

Building simulation as a real design tool -

Applications in international projects from Frank O. Gehry to Helmut Jahn

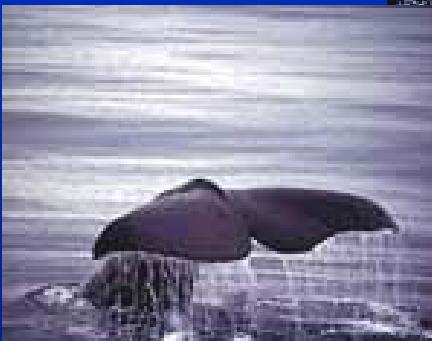
Matthias Schuler
TRANSSOLAR Klimaengineering - Stuttgart/Munich/New York
www.transolar.com

Washington, 9-11-2003

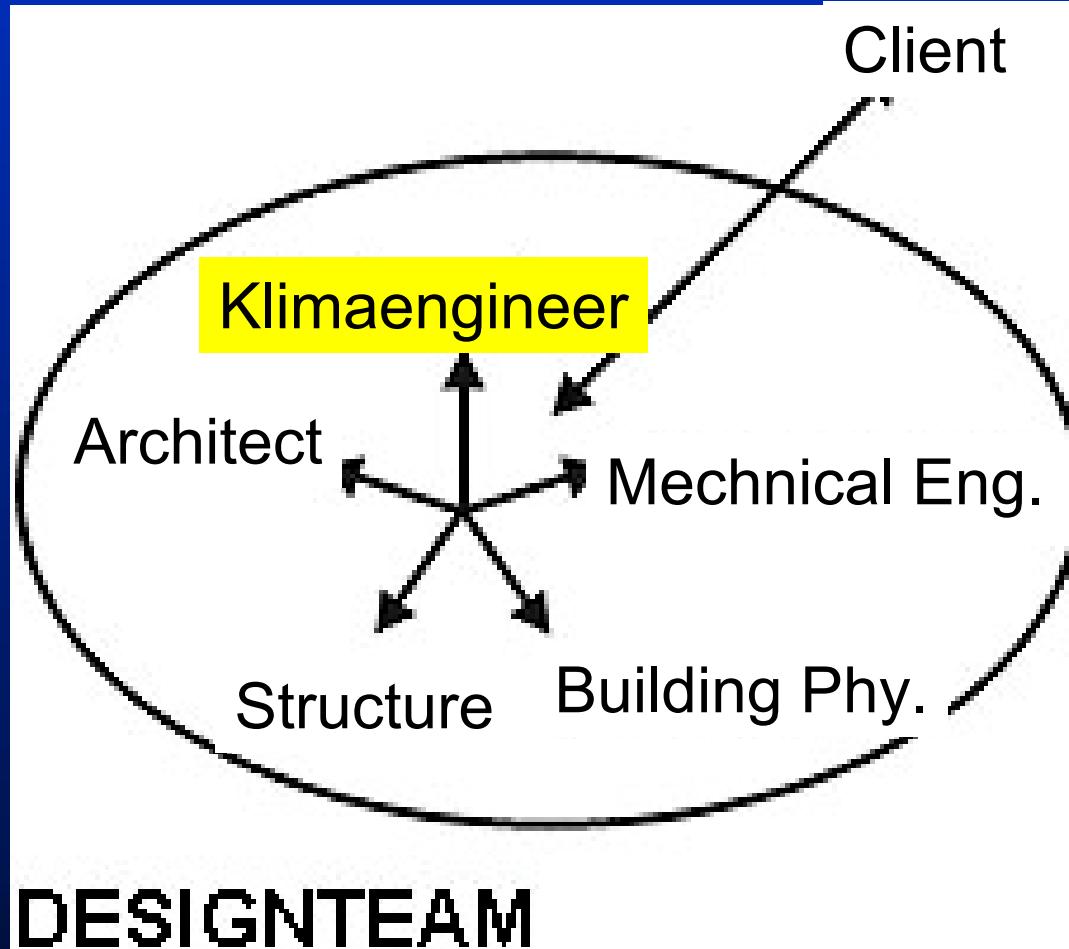


Overview

- **Introduction Concept philosophy**
- **TRNSYS Software**
- **Project Overview**
- **A Project in Detail**



Sustainability today as respect for nature and future



Sustainable approach in the design team

Year of foundation:	1992
Managing directors:	M. Schuler, Prof. Dr. T. Lechner, P. Voit T. Auer, S. Holst, V. Bleicher
Turnover 2002:	3.7 Mio €

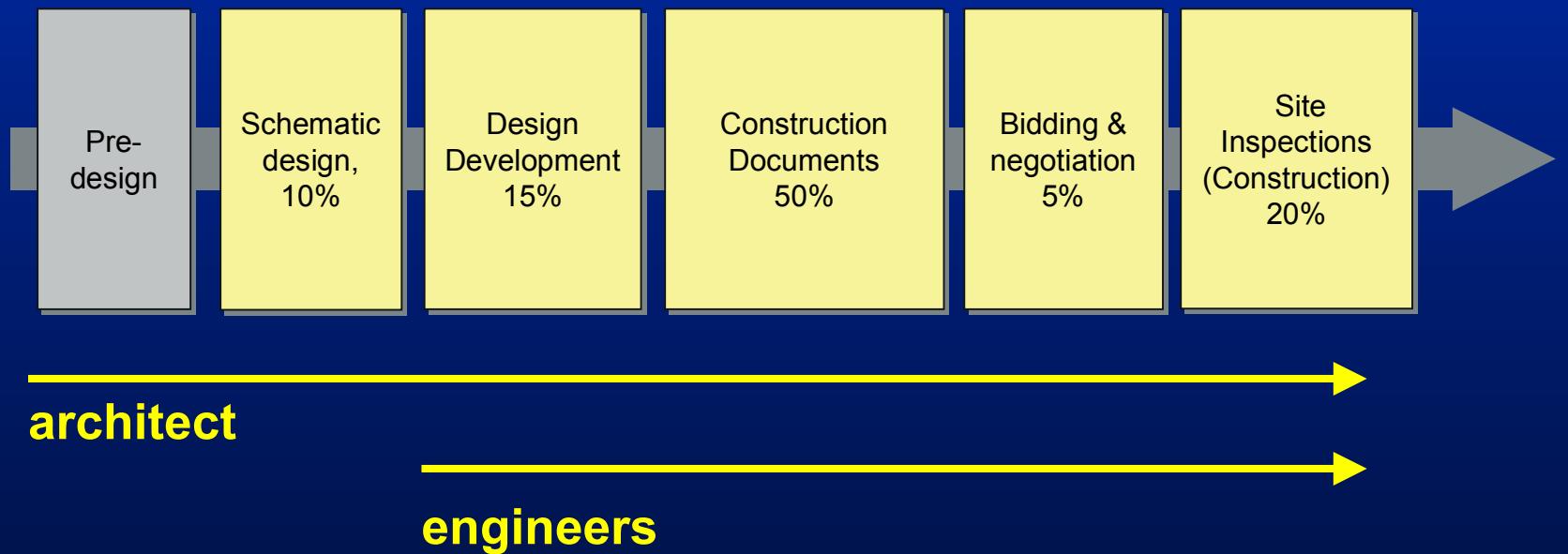
Number of employees and their specialist areas:

Number of employees:	1	1992
	38	2002

Qualification : Mechanical engineer,
 Physicist,
 Industrial Process engineer,
 Management expert,

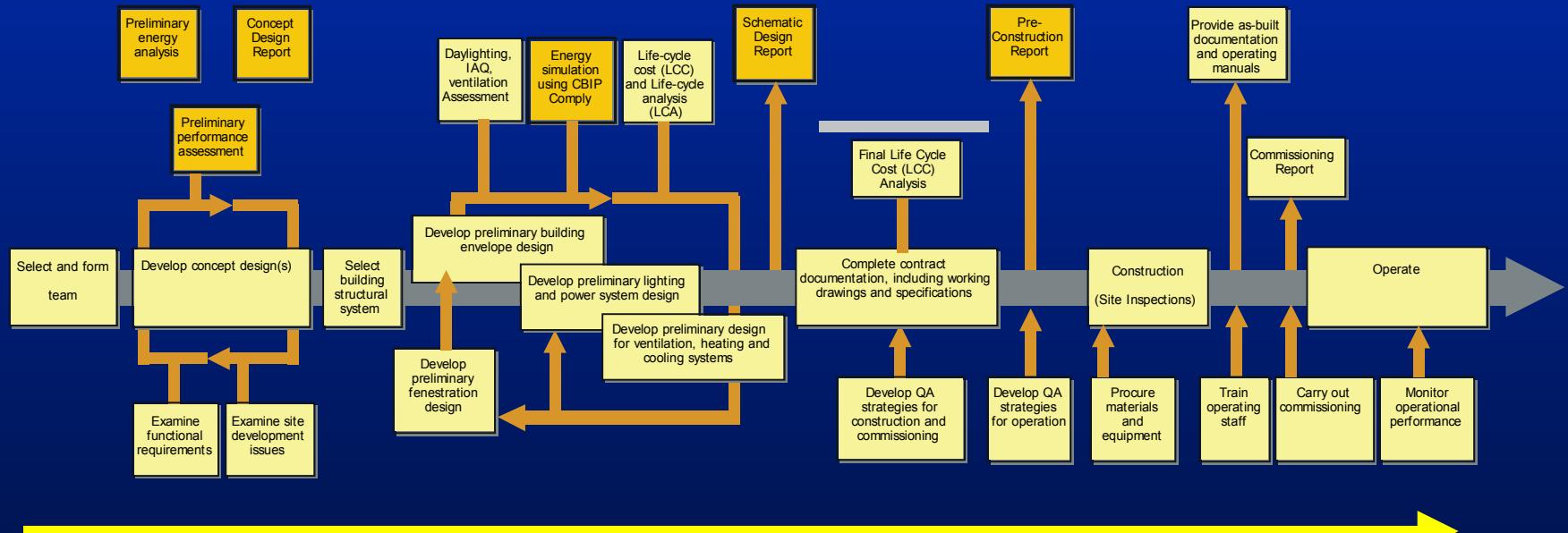
Project locations:	Germany	75%
	other Europe	10%
	Asia	5%
	North America	10%

- Linear
- fast
- no iteration
- no common concept
- engineers have to solve architectural design caused problems



Classical linear design process

- in spirals with recirculation
- slower
- reiteration - optimization
- common design team concept
- solutions by concept not by components

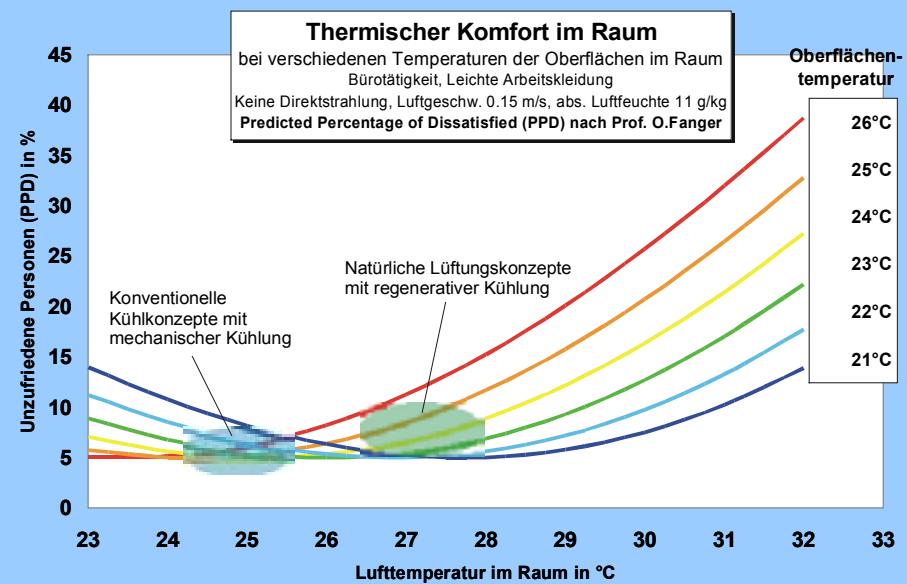
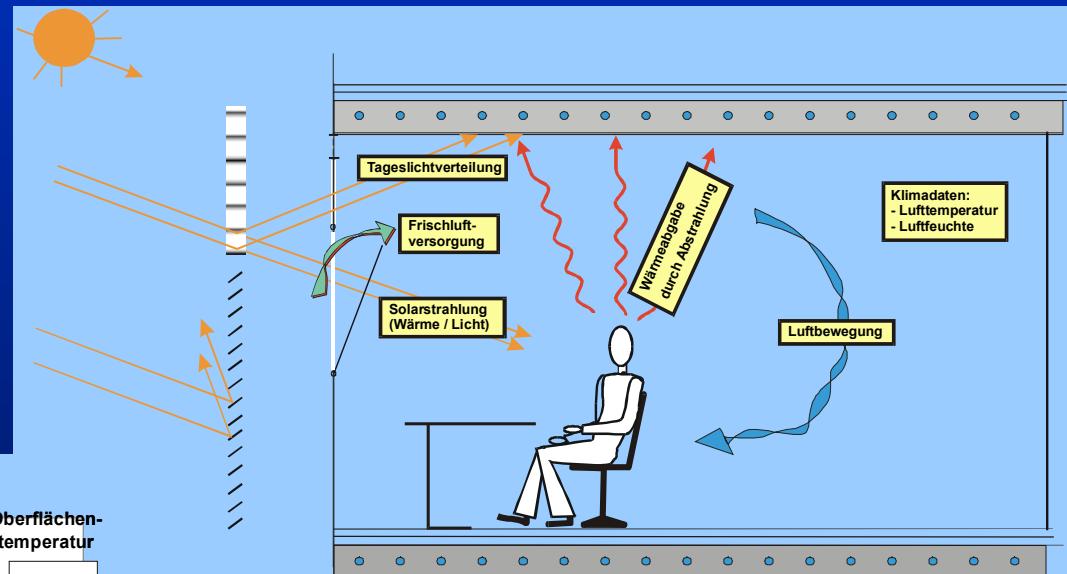


Whole team (architects, engineers, client, users)

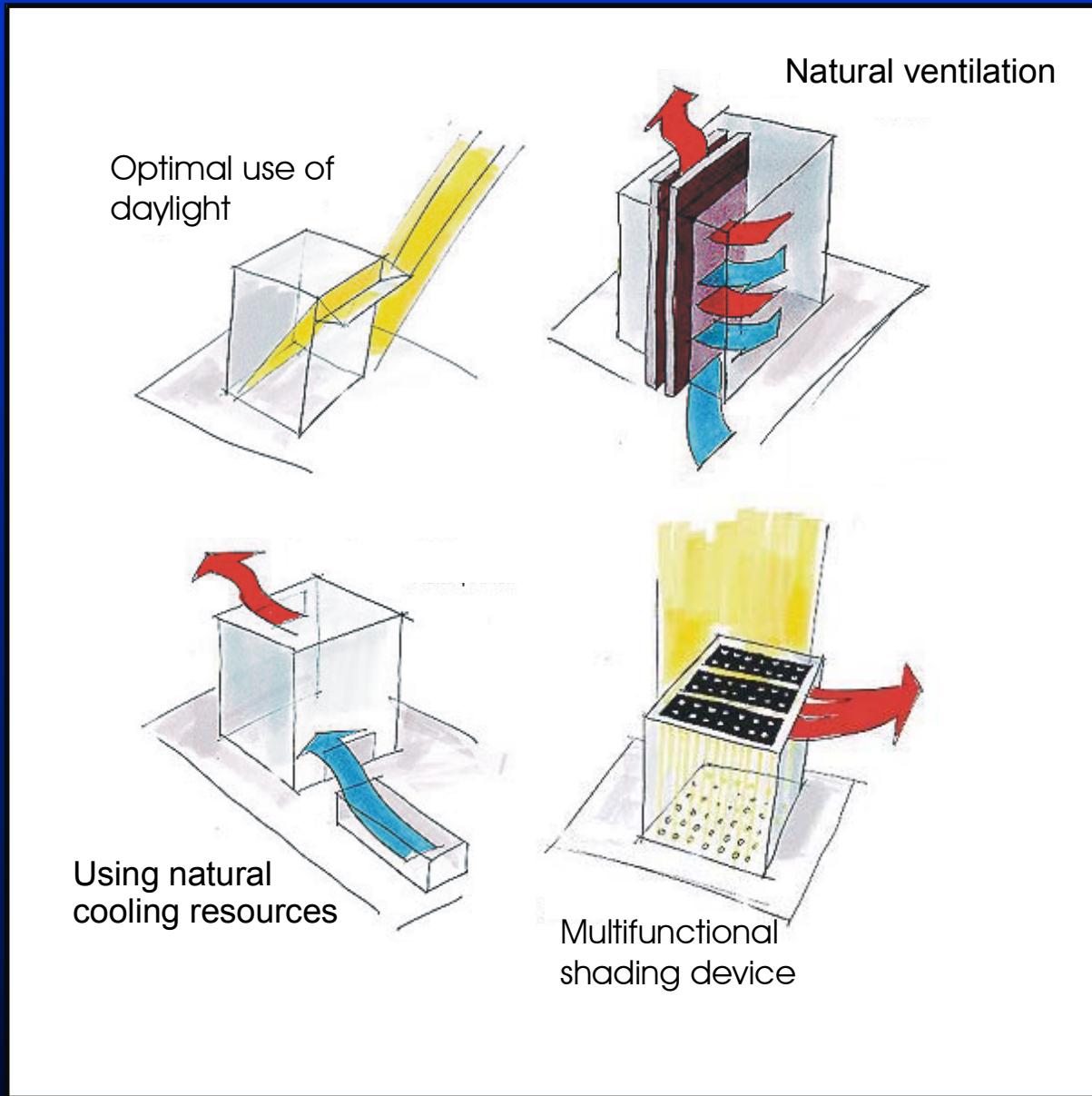
Integral design process

Thermal Comfort influences

- Air temperature
- Radiation temperature
- Solar radiation
- Air velocity
- Humidity
- Activity
- Clothing



Comfort evaluation DIN/ISO 7730



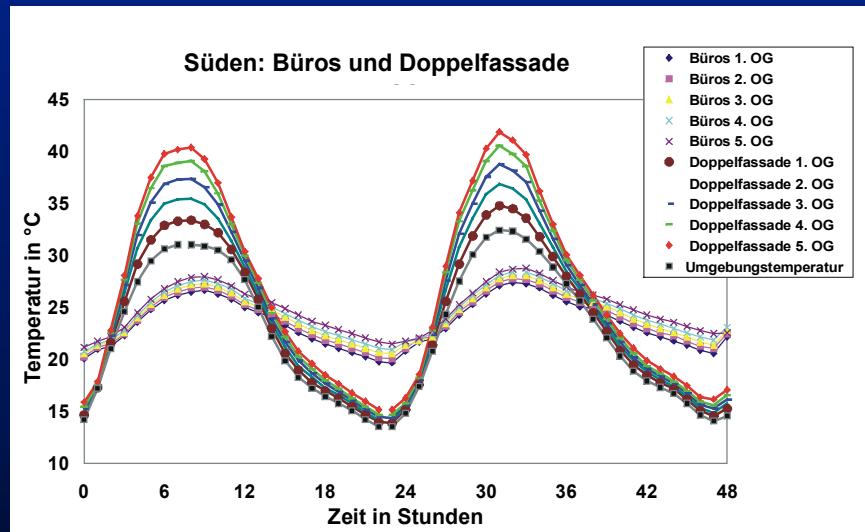
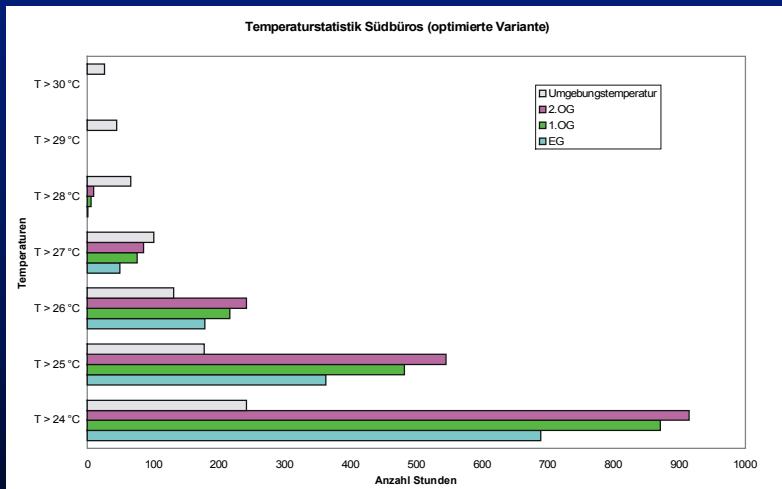
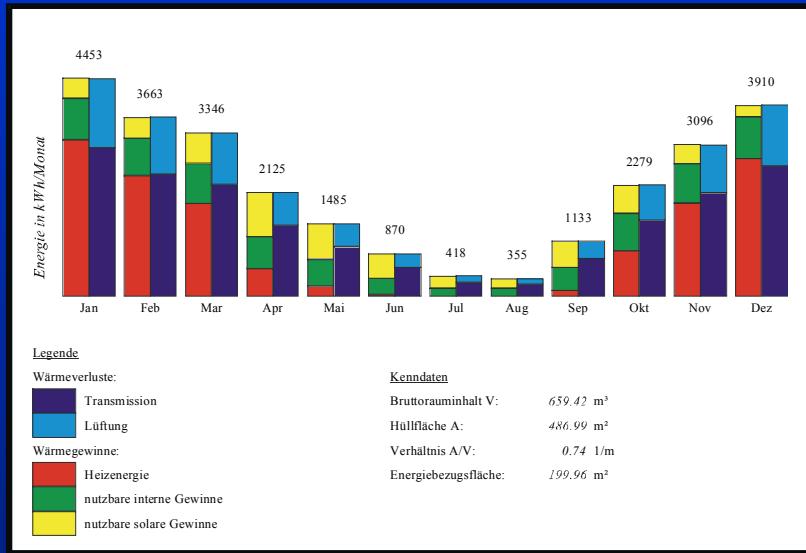
Concept approaches

- To check the concept function
 - To check component effects
 - To size building and system components
 - To evaluate decision consequences
-
- by:
 - occupants comfort
 - temperature statistics
 - energy demands and peak loads
 - air flows and distribution
 - air quality
 - illumination and glare
 - operation costs

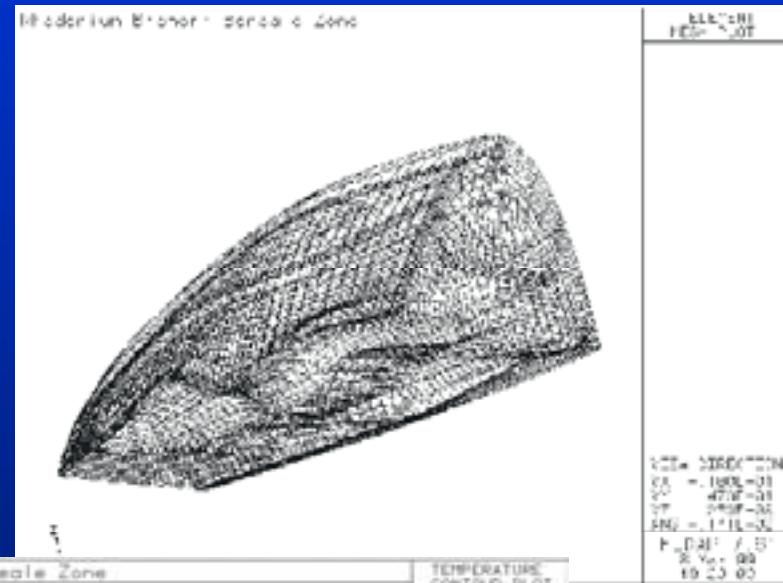
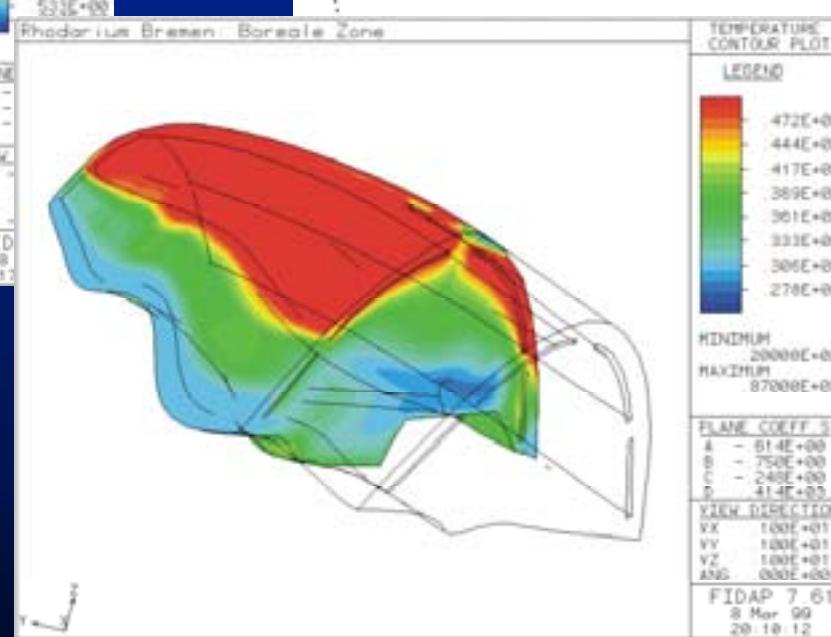
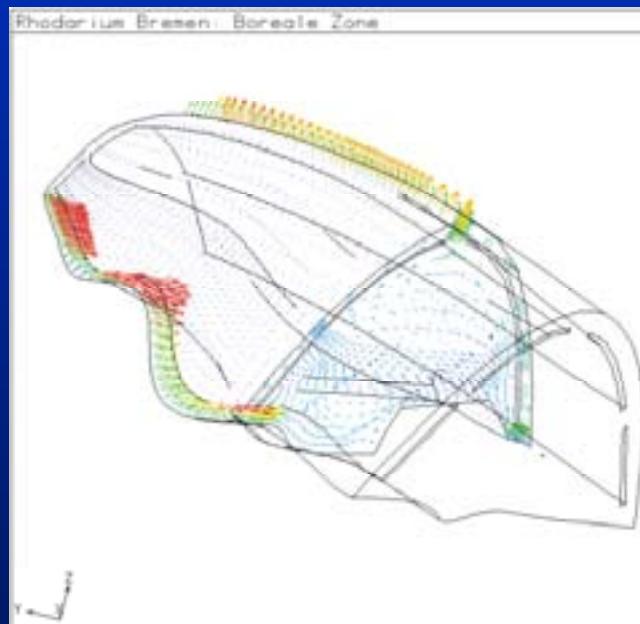
**Simulation engineer has to take responsibility for his results !
depending on agreed boundary conditions like occupancy, materials,
dimensions etc.**

Concept evaluation by simulation

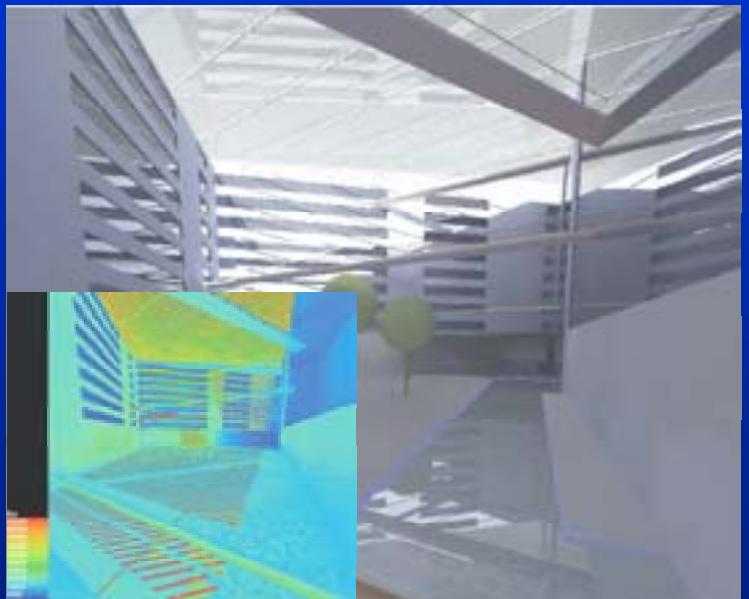




Dynamic building load and systems simulation

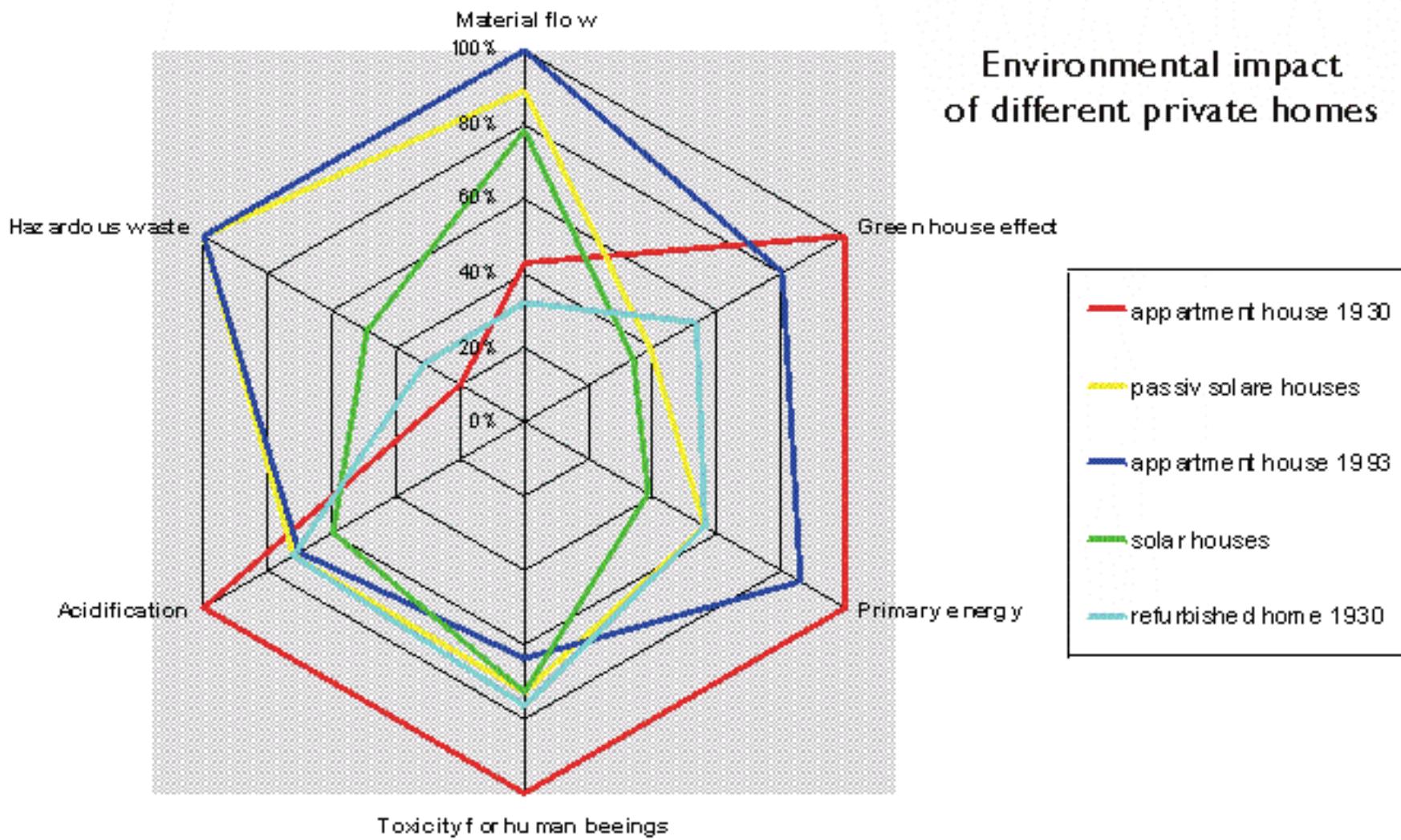


Computational fluid dynamic simulation



Daylight and artificial lighting simulation

Environmental impact of different private homes



Life cycle analysis

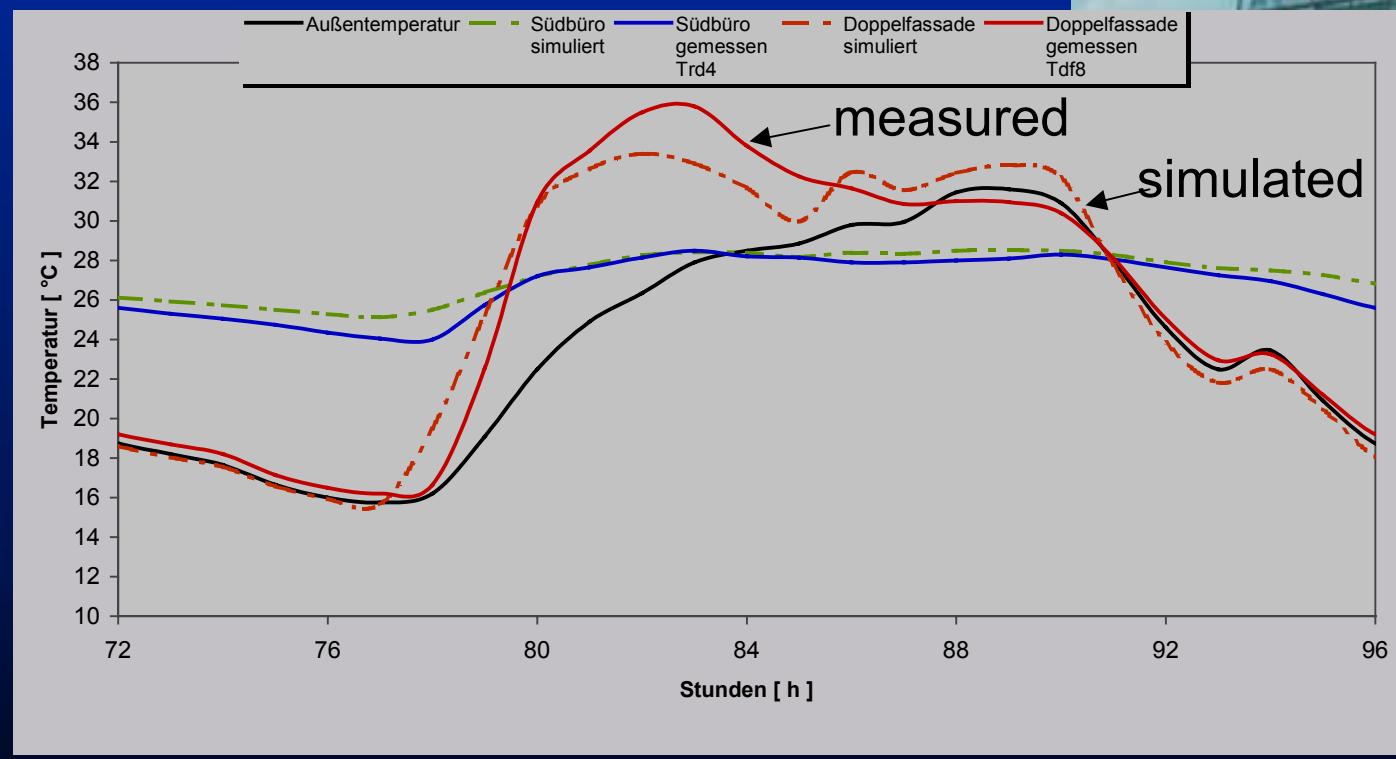
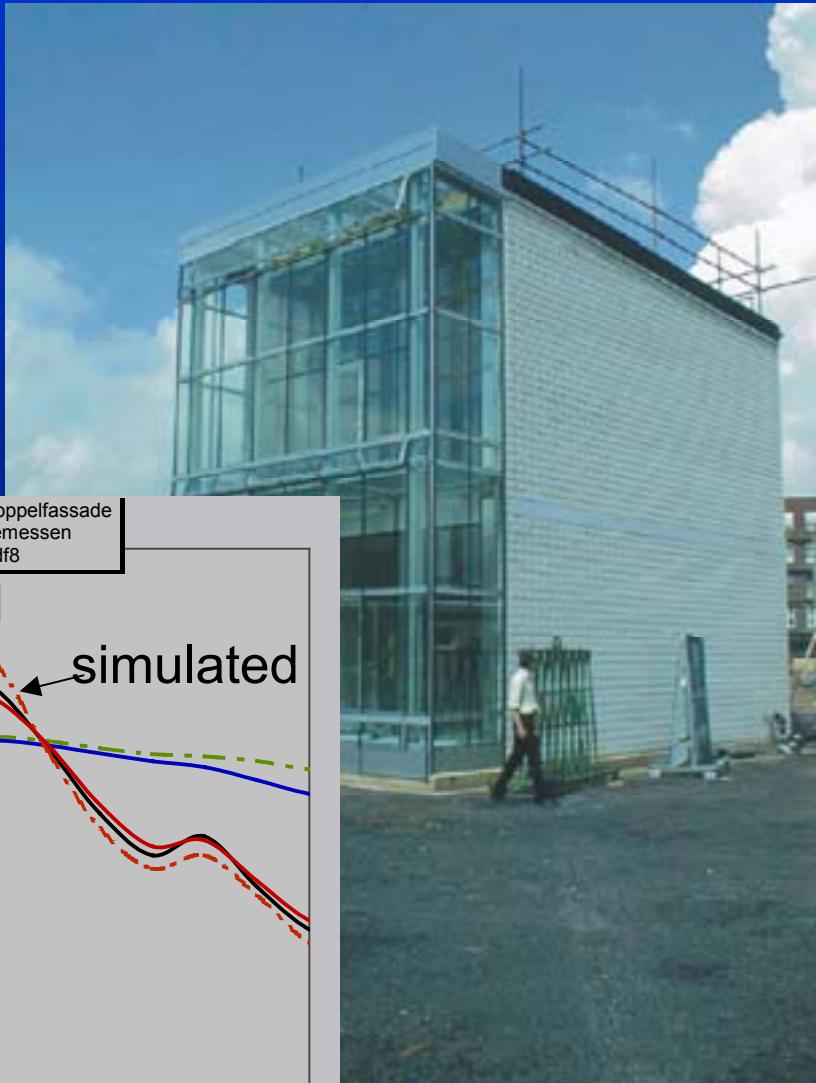
Concept Analysis of 1:1 Mockup and Buildings

- component test like glazings, air i/e units, shading devices
- facade and test room measurements for comfort
- short term measurements of realised concepts
- - long term evaulation of realised concept related to energy use for heating cooling lighting ventilation

Concept Analysis of 1:1 Mockups and Buildings in Use



Concept evaluation 1:1 Modell



Mockup Headquater Bayer AG



- **TRNSYS15**
 - More than just a tool
 - With TRNSYS you can do nearly everything...
 - If not yet defined, just develop a new component

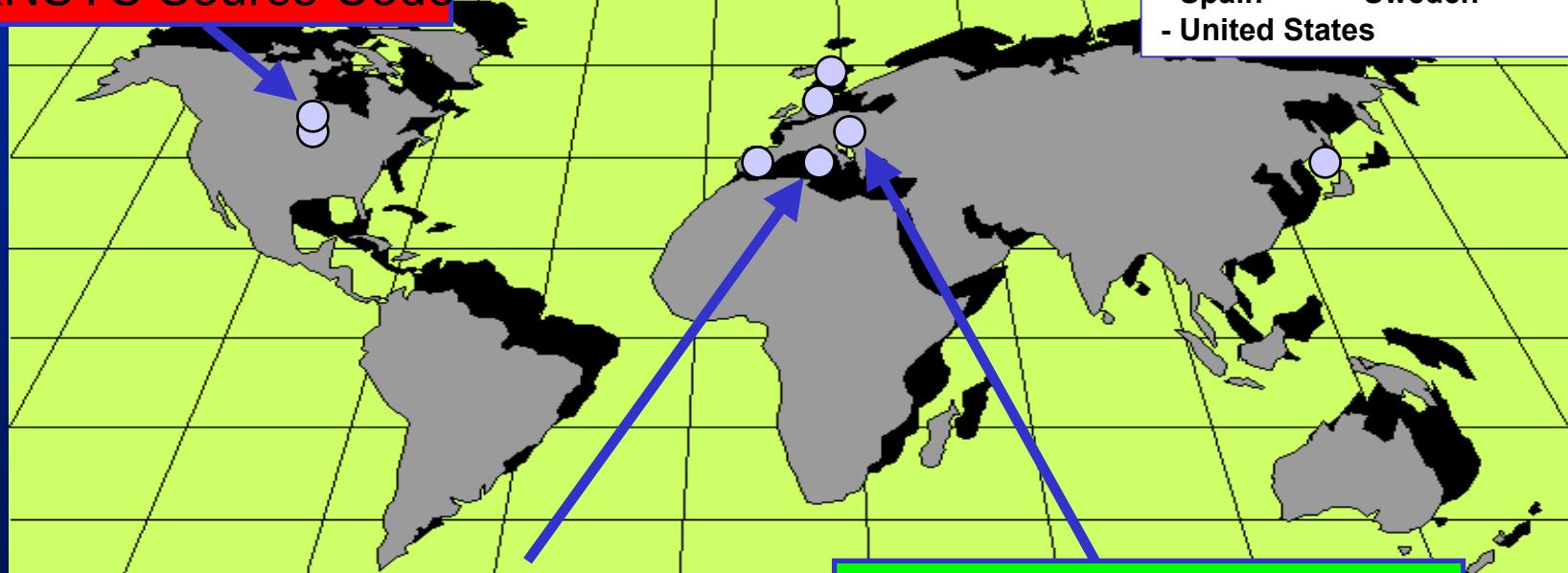


- **Application:**
 - Buildings
 - Active and passive solar systems
 - Integrated energy concept
- **Characteristics:**
 - Modular approach
 - Flexible input / output
 - Large component library incl. multi-zone building model (TYPE56)
 - User-friendly interfaces
 - International application (research and consulting)
 - open structure !

SEL/TESS : 
TRNSHELL, TRNSED
TRNSYS Source Code

Distributors

- Belgium
- France
- Spain
- United States
- Germany
- Japan
- Sweden



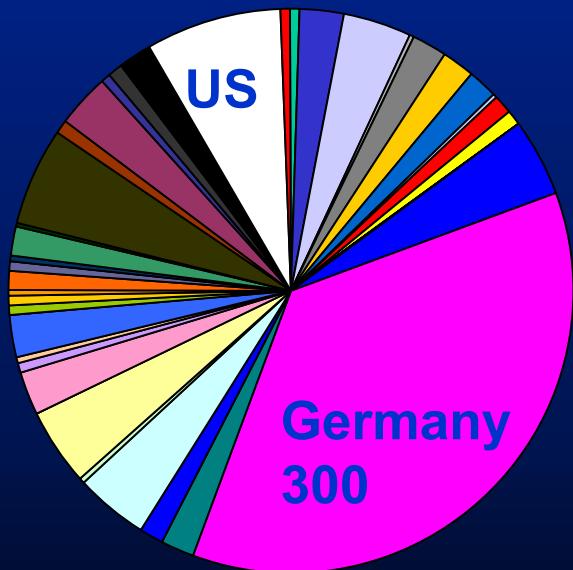
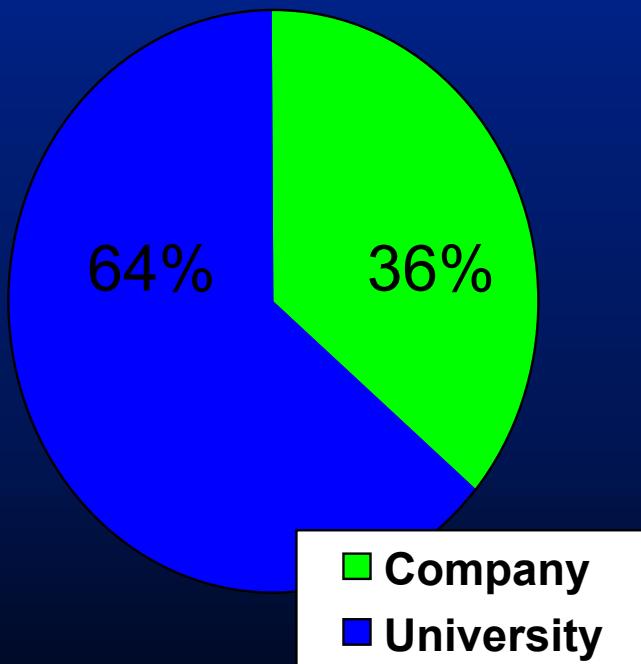
CSTB : IISiBat
Graphical Front-end 

 TRANSOLAR :
Multi-zone building modell
PREBID

Developers and Distributors

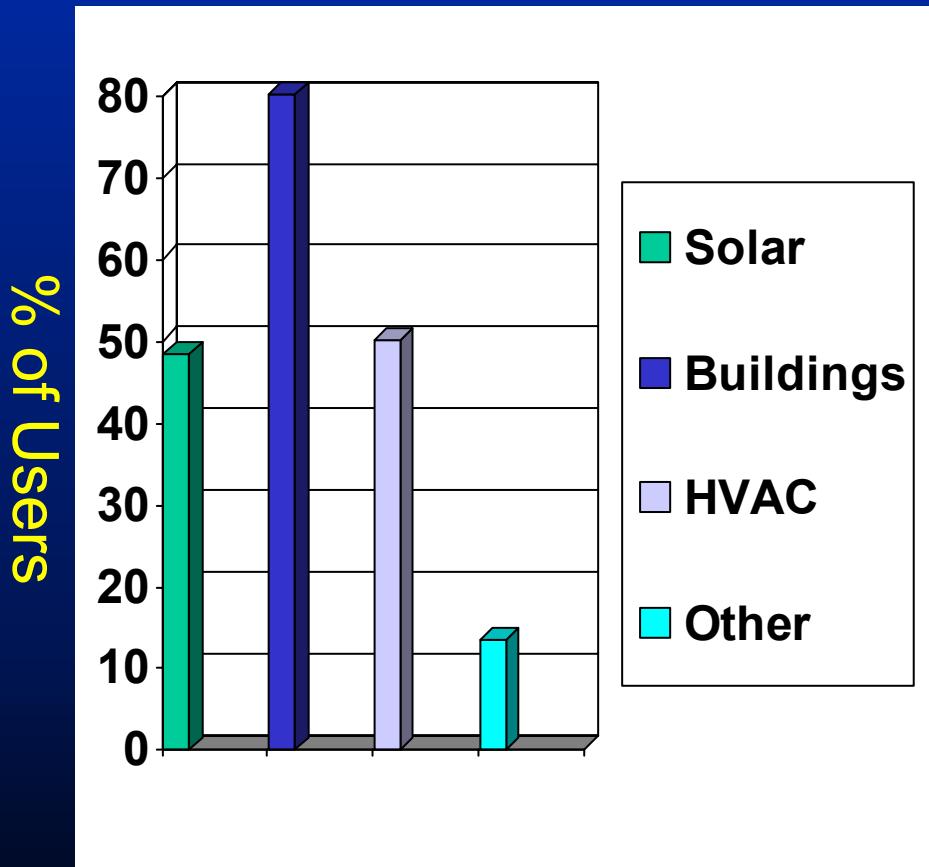


- TRNSYS 15 users
- TRNSYS 15 is distributed to 40 countries



Algeria
Australia
Austria
Bahrain
Belgium
Brazil
Canada
Chile
China
Czech Republic
Denmark
Finland
France
Germany
Greece
India
Indonesia
Italy
Jamaica
Japan
Kenya
Korea
Luxembourg
Malaysia
Mexico
Netherlands
New Zealand
Norway
Oman
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Spain
Sweden
Switzerland
Syria
Thailand
United Kingdom
USA
Yougoslavia

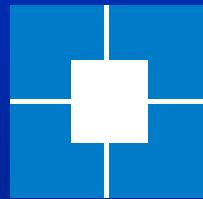
Main Applications: TRNSYS is used for:



Additional Types of Applications

- Comfort conditions inside cars
- District heating systems
- Power plants

70% use TRNSYS for two or more types of problems



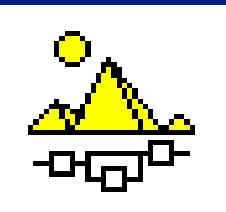
SIMCad
for TRNSYS



Multi-zone building
& PREBID

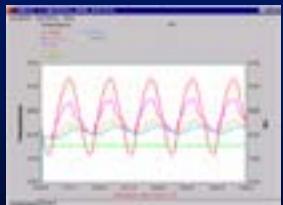


TRNFlow -
interzonal air flow model

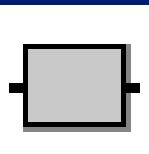


IISiBat 3 -
graphical interface

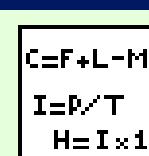
Graphical output: ONLINE



Quick
and easy



Large component
library

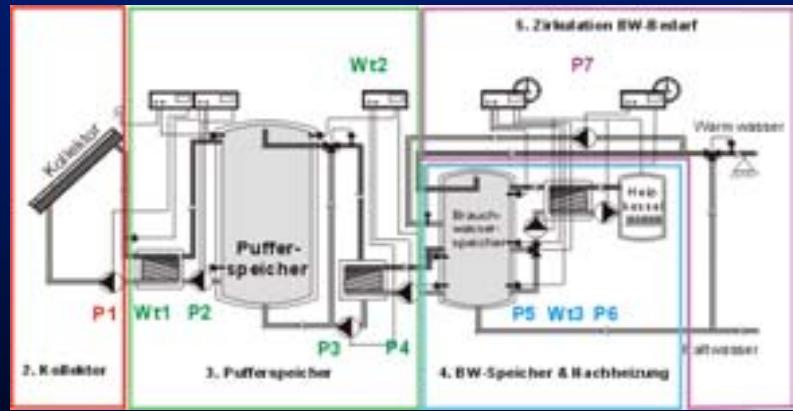
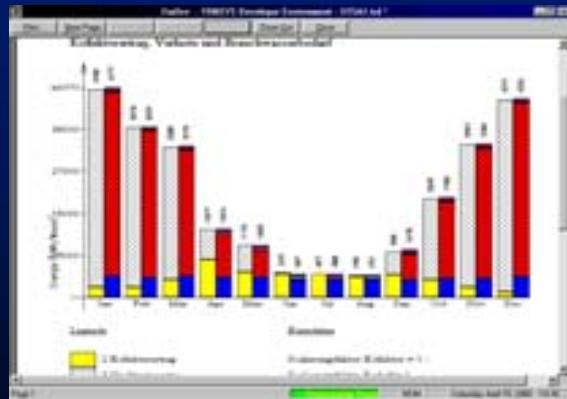
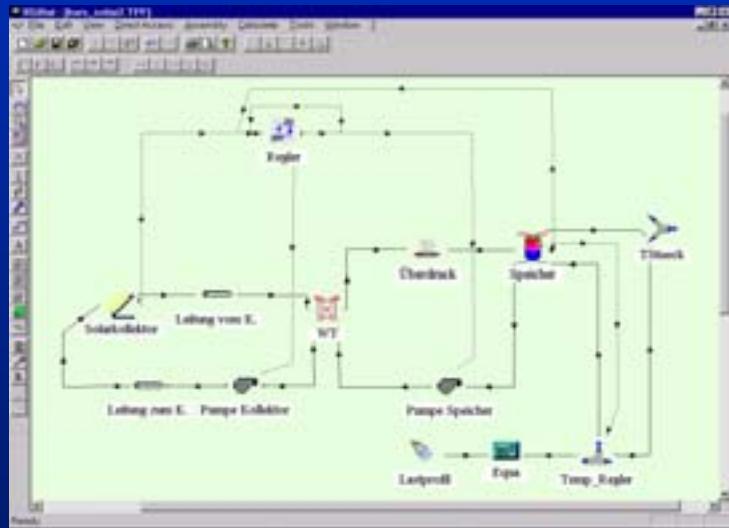


source code

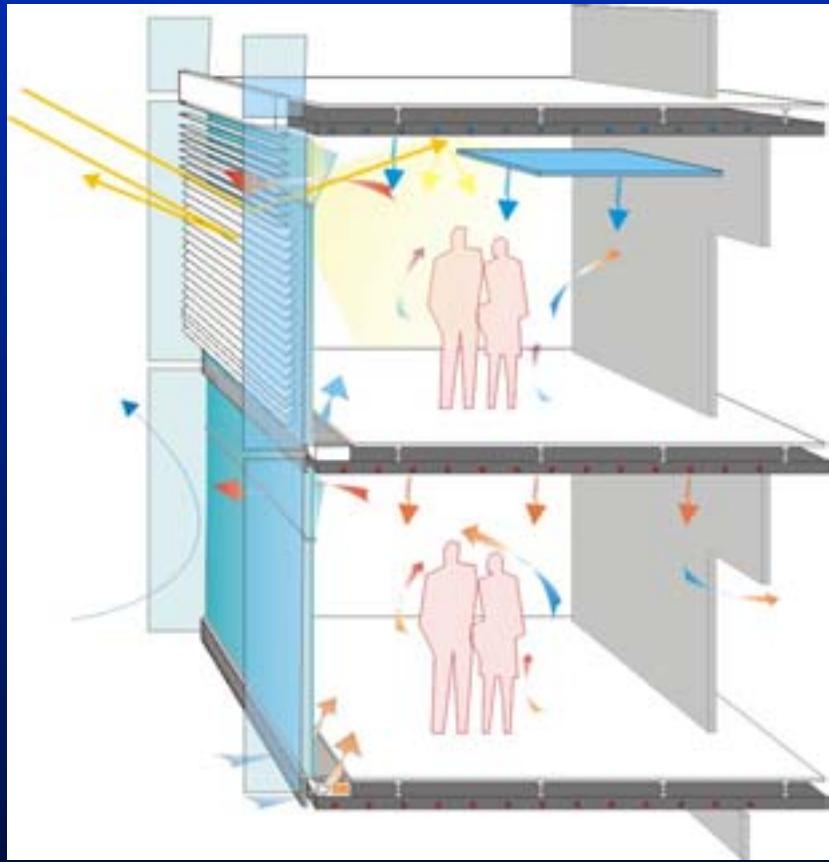
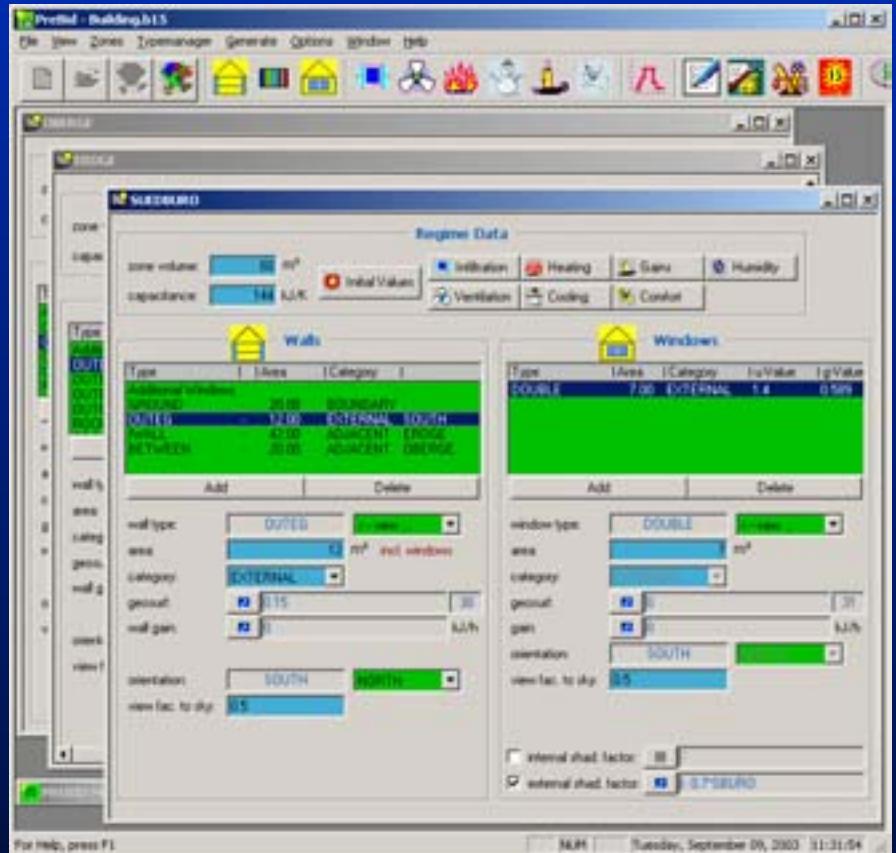


Hotline service

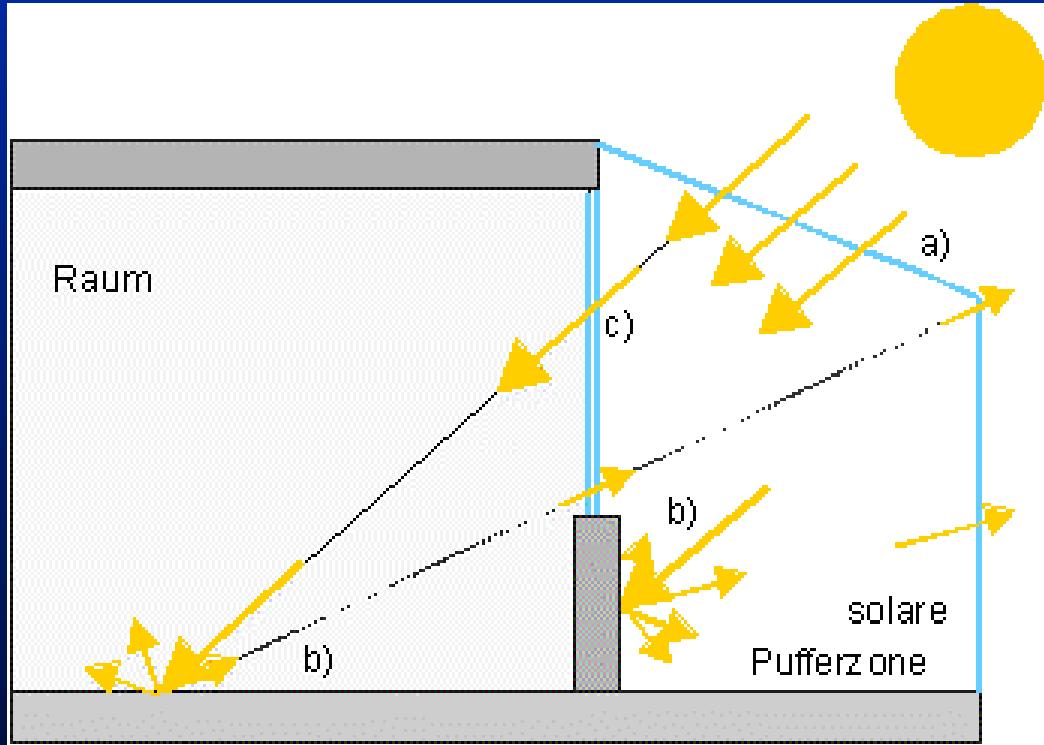
The TRNSYS Package



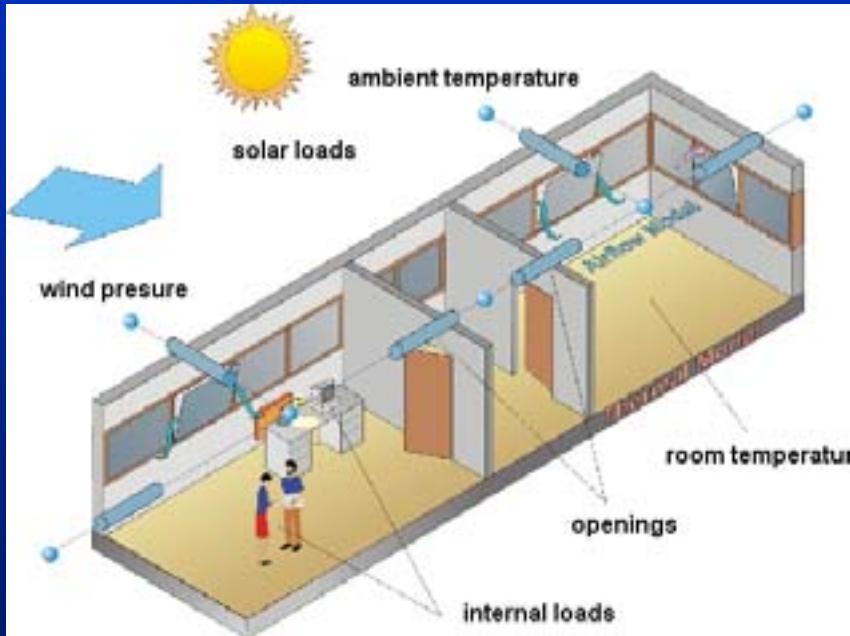
**Parallel System and load simulation:
solar assisted space heating**



Multi-zone building model with all kind of building components and mechanical systems

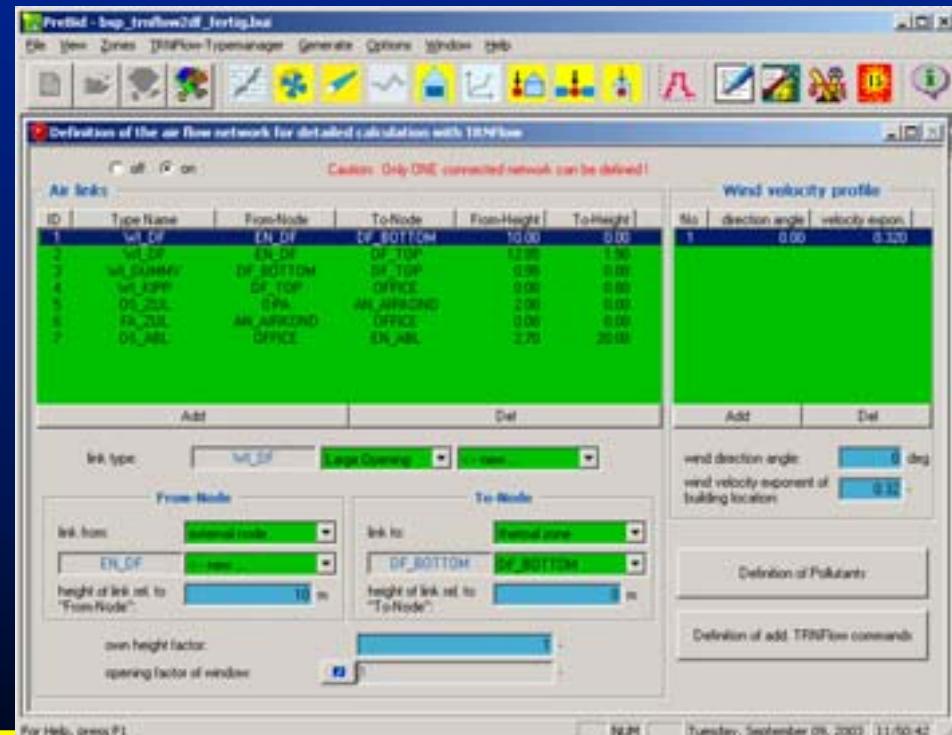


Thermal buffer spaces: Winter gardens, double façades and atriums

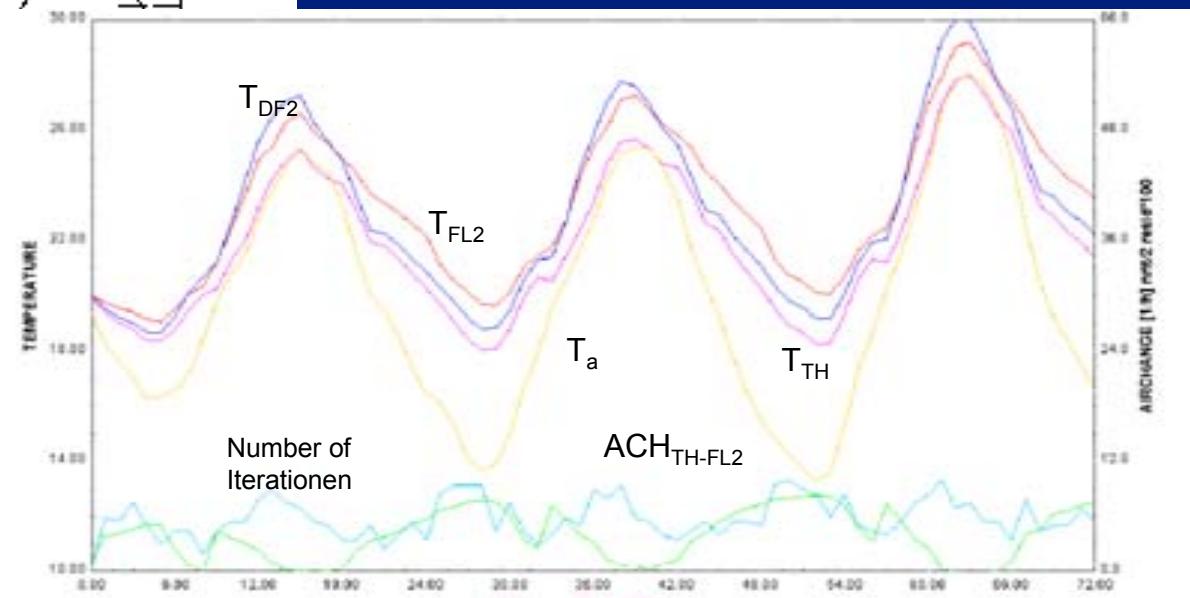
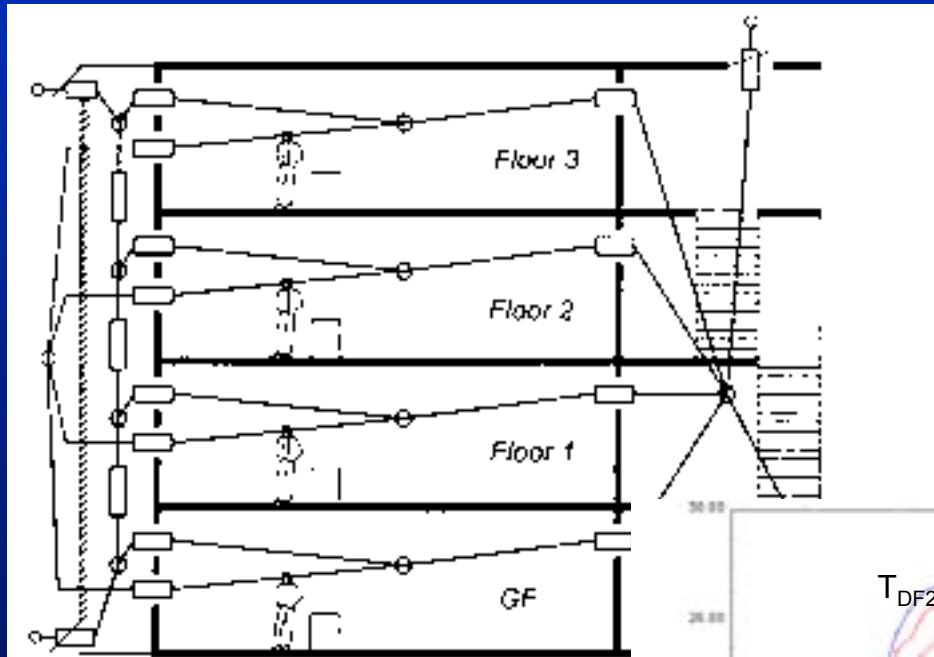


Integrated air flow model is based on COMIS 3.1

Air flow and thermal model is coupled internally (new solver)



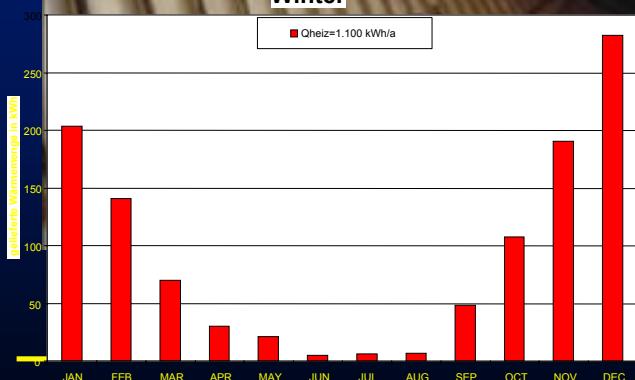
Air flow network simulation with TRNFLOW



Example double facade: Evaluation by TRNFLOW



Winter

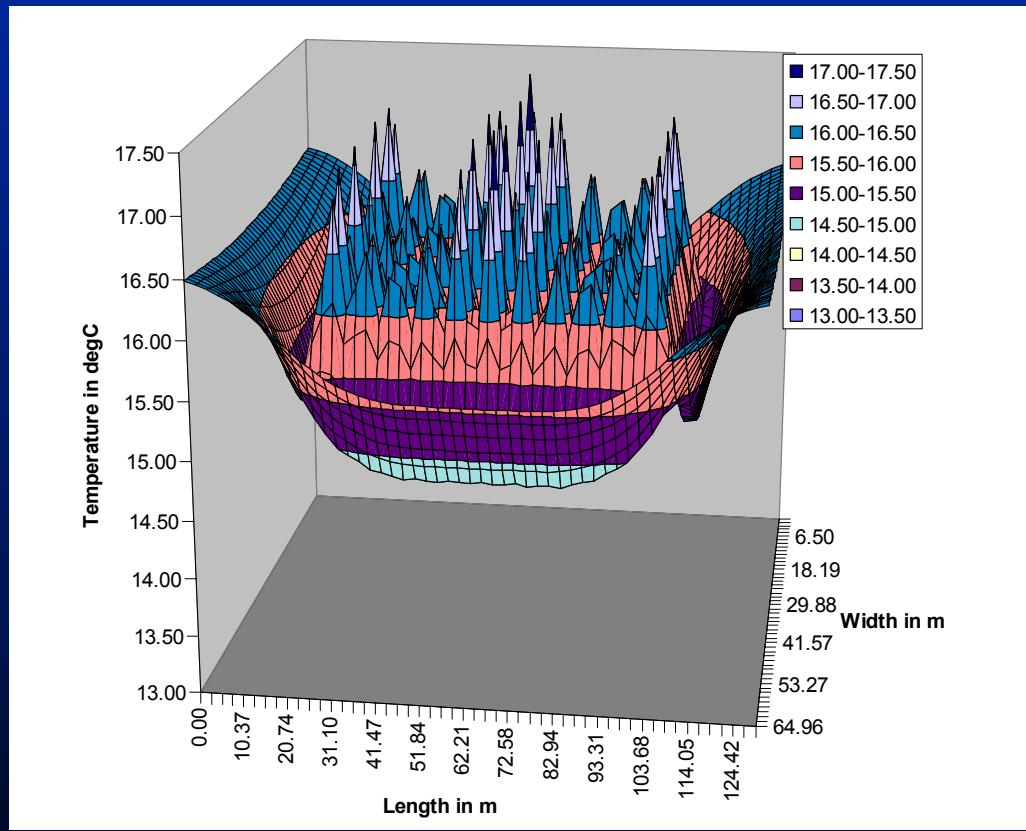


Sommerbilanz

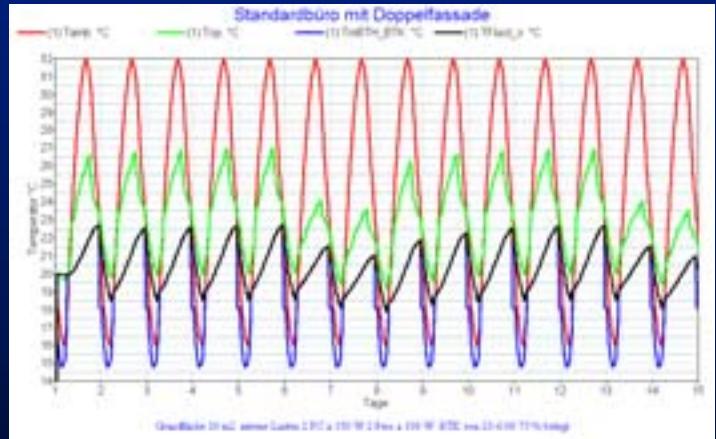
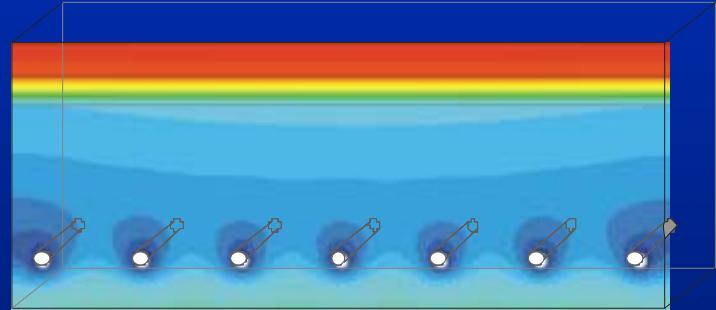




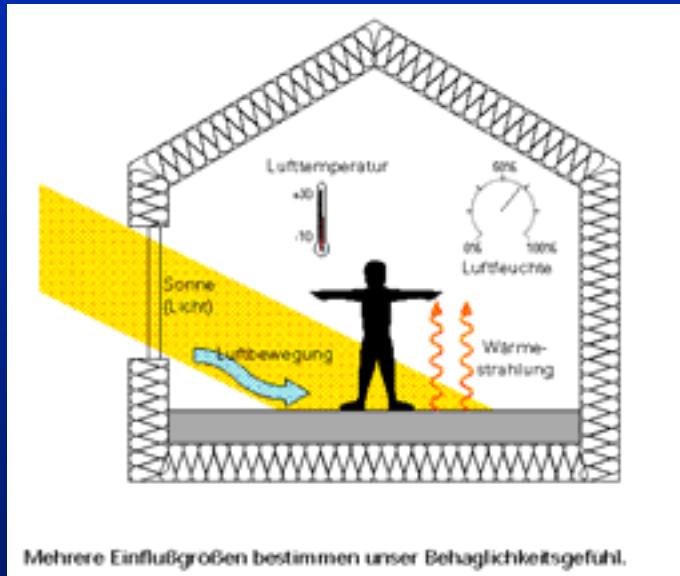
Detailed modelling of 3-D temperature field



Regenerative cooling with ground source heat exchangers



**Comfort improvement with slab cooling
- embedded piping**

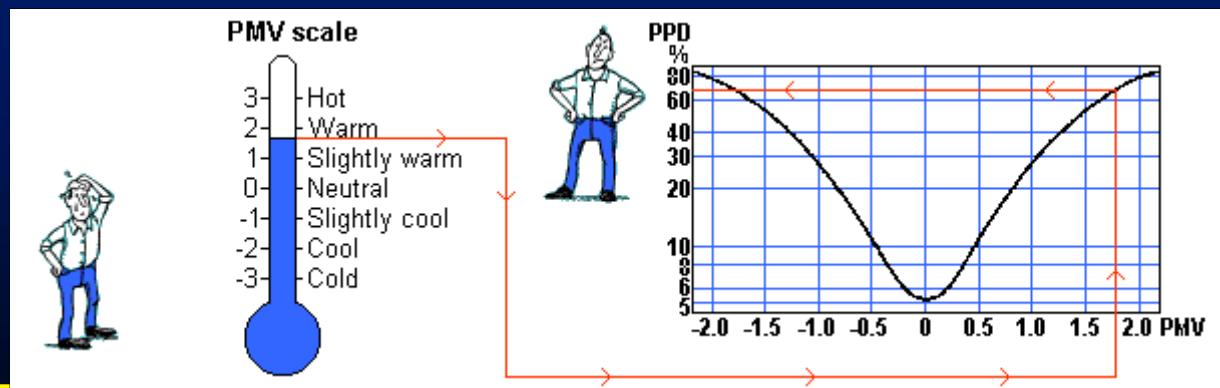


New Comfort Type

 new comfort type: COMF001

Clothing factor:	<input checked="" type="checkbox"/> 1	clo
Metabolic rate:	<input checked="" type="checkbox"/> 1	met
External work:	<input checked="" type="checkbox"/> 0	met
Relative air velocity:	<input checked="" type="checkbox"/> 0.1	m/s

OK Cancel

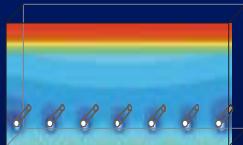


Comfort evaluation based on EN ISO 7730

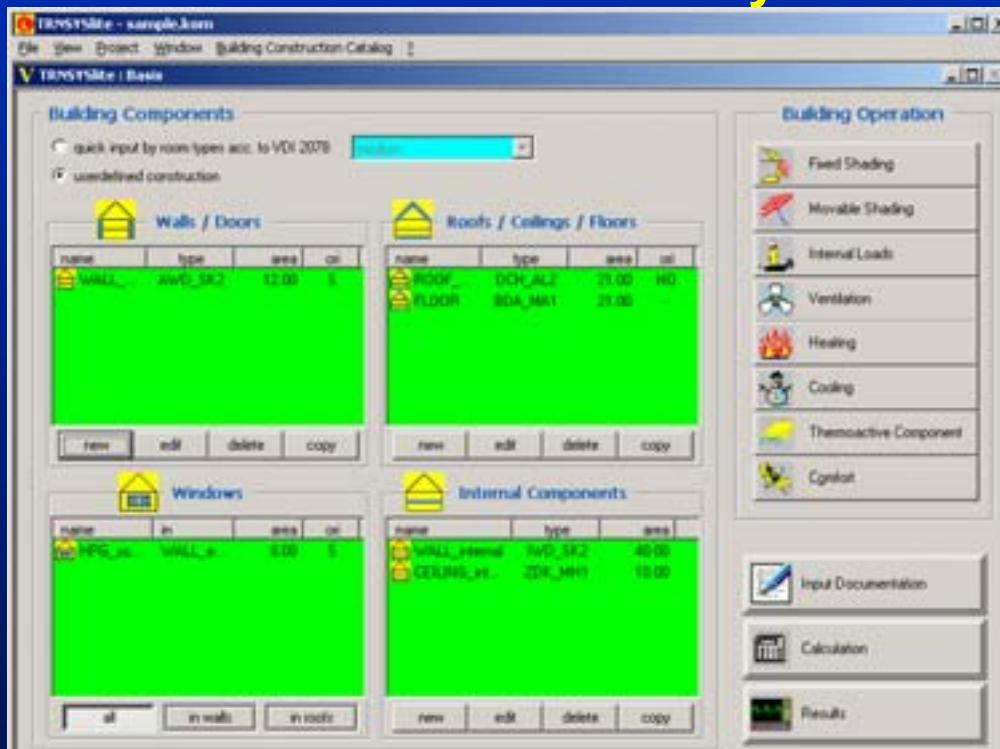
Case management



Large building component library incl. tab



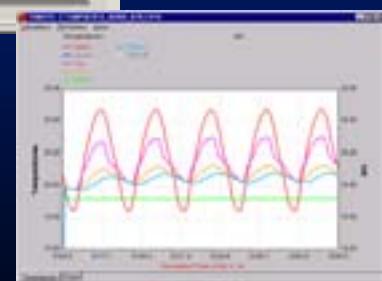
Userfriendly interface



Online results

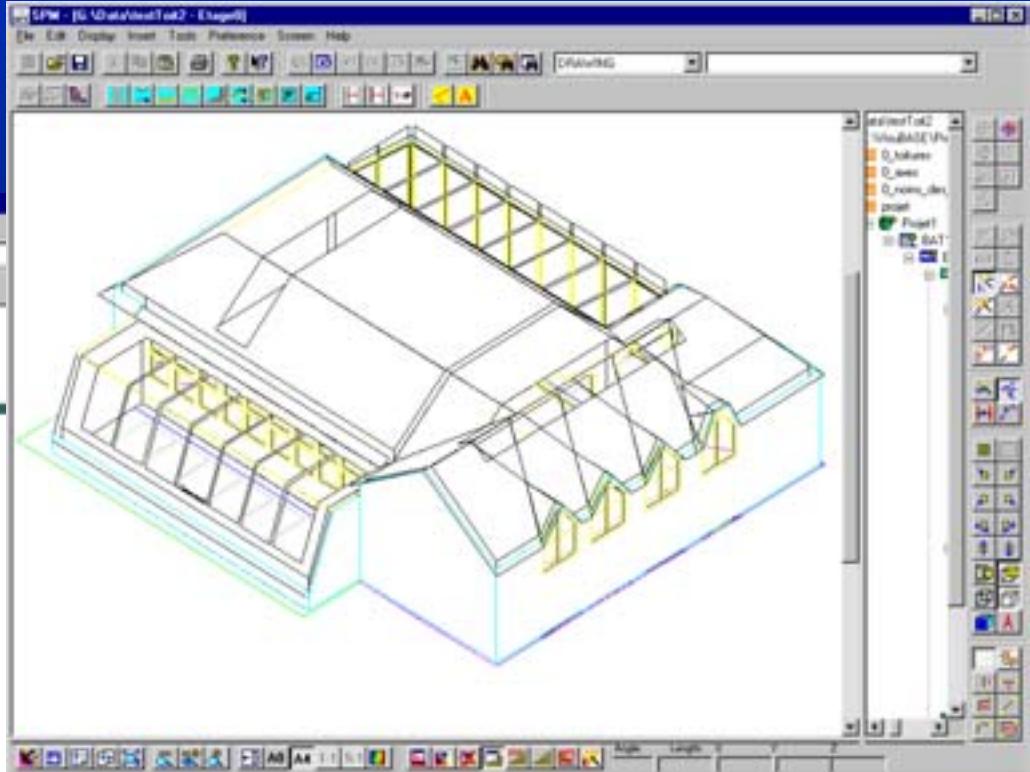
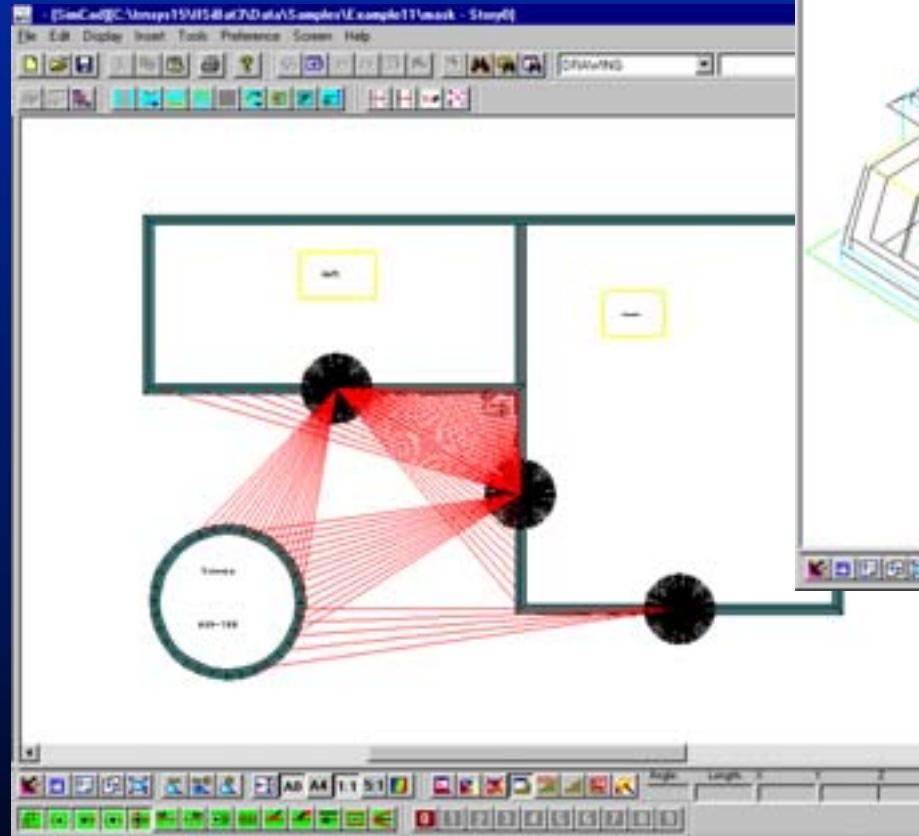


Further simulations with TRNSYS 15 possible



TRNSYS/*lite* - quick and easy building simulation

Shading by adjacent structures



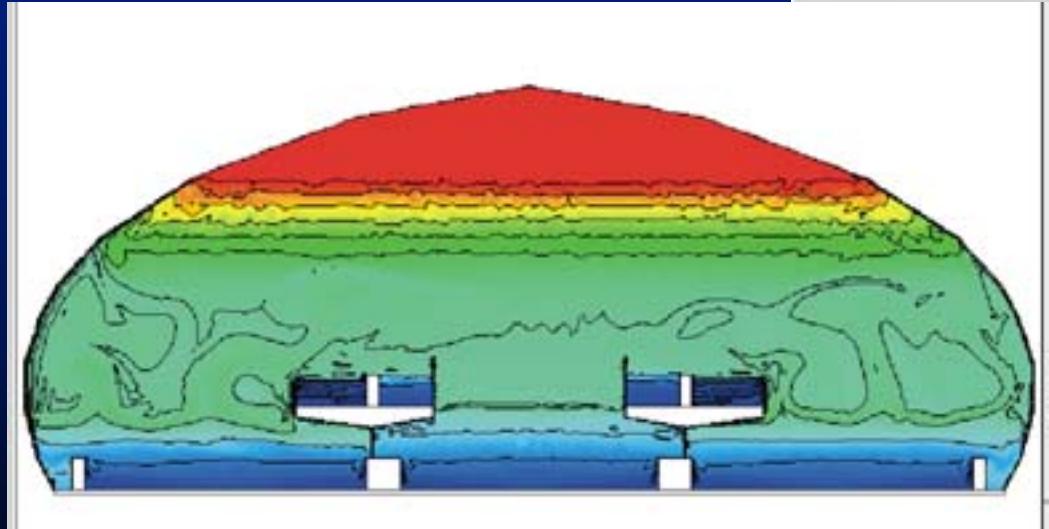
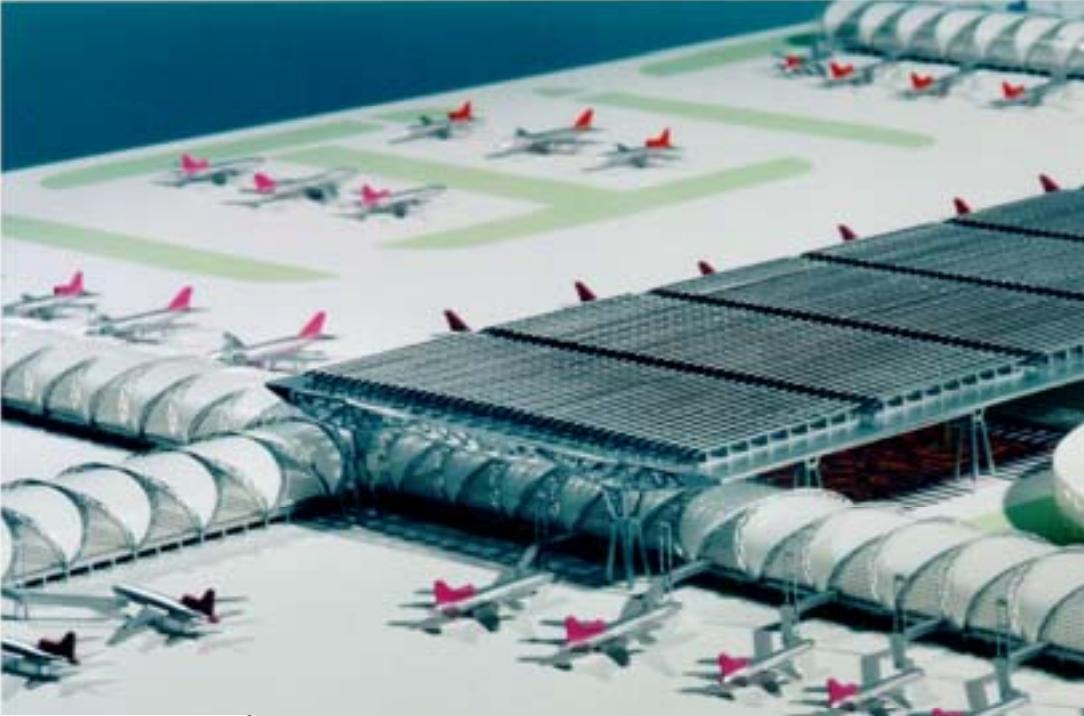
Import building data
from .dxf files

CAD data input with **SIMCAD**

Project examples

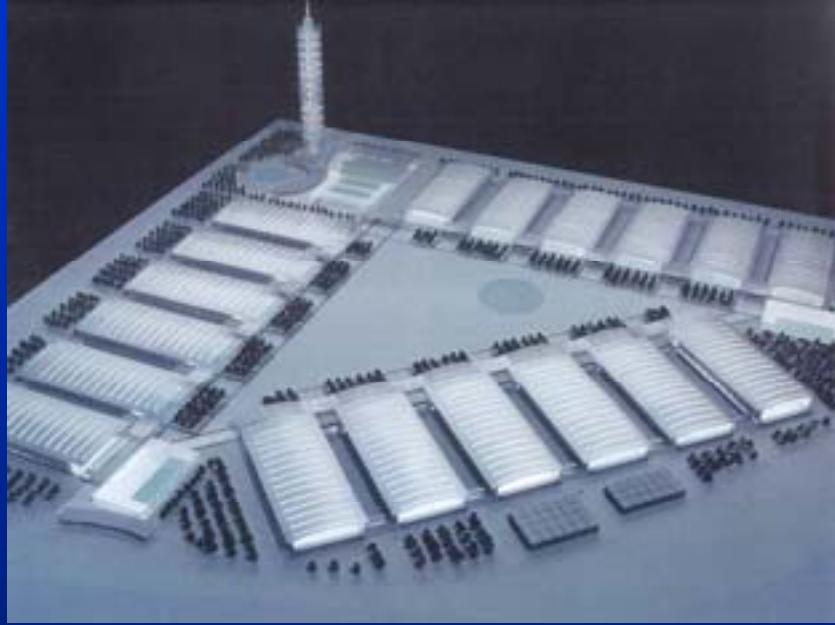
Design Team

Architect: Murphy/Jahn,
Structural Engineer: Werner Sobek Ing.
Climate Engineering: TRANSOLAR
Acoustical Consultant: Dr. Rainer Blum
Mechanical Engineer: Flack and Kurtz



Concept:
stratification, displacement ventilation
low-e membrane
floor cooling

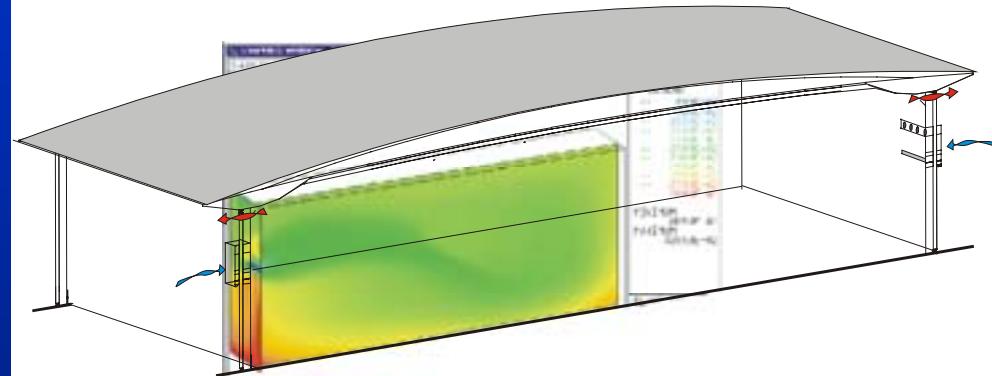
New Bangkok International Airport



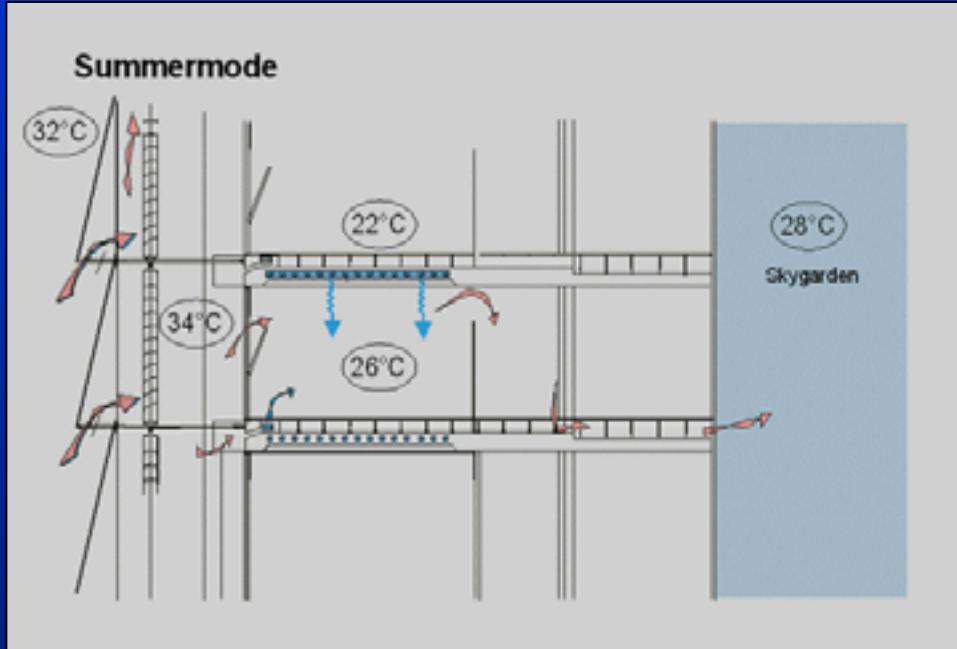
Architects: Murphy/Jahn, Chicago
Structure: Werner Sobek Ing.
Energy concept: Transsolar
HVAC: Schreiber Ingenieure
Electro: IngenieurbüroSchwarz

Concept: Wall integrated air jet units
translucent membrane roof

Summer Mode
temperature distribution



Shanghai New International Expo Center



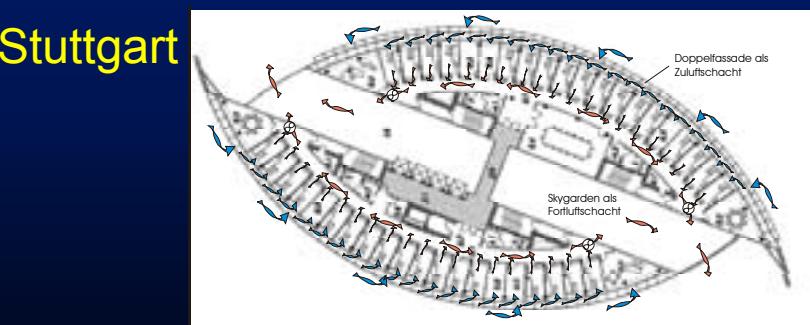
Client: Deutsche Post AG

Architect: Murphy / Jahn, Chicago

Structur: Werner Sobek Ingenieure, Stuttgart

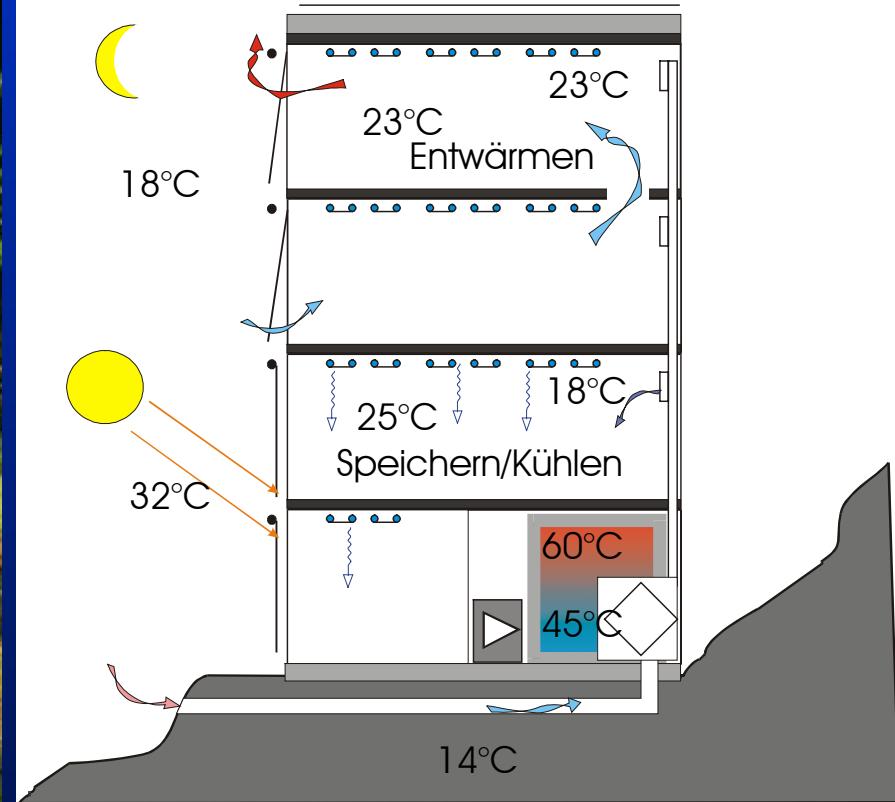
Energy Concept: Transsolar, Stuttgart

MEP Consultant: Brandi Consult, Berlin



- Headquarter Deutsche Post, Bonn

Sommerkonzept



Architecture/Structure: Werner Sobek Ing
Energy Concept: Transsolar

R128 - Experimental House

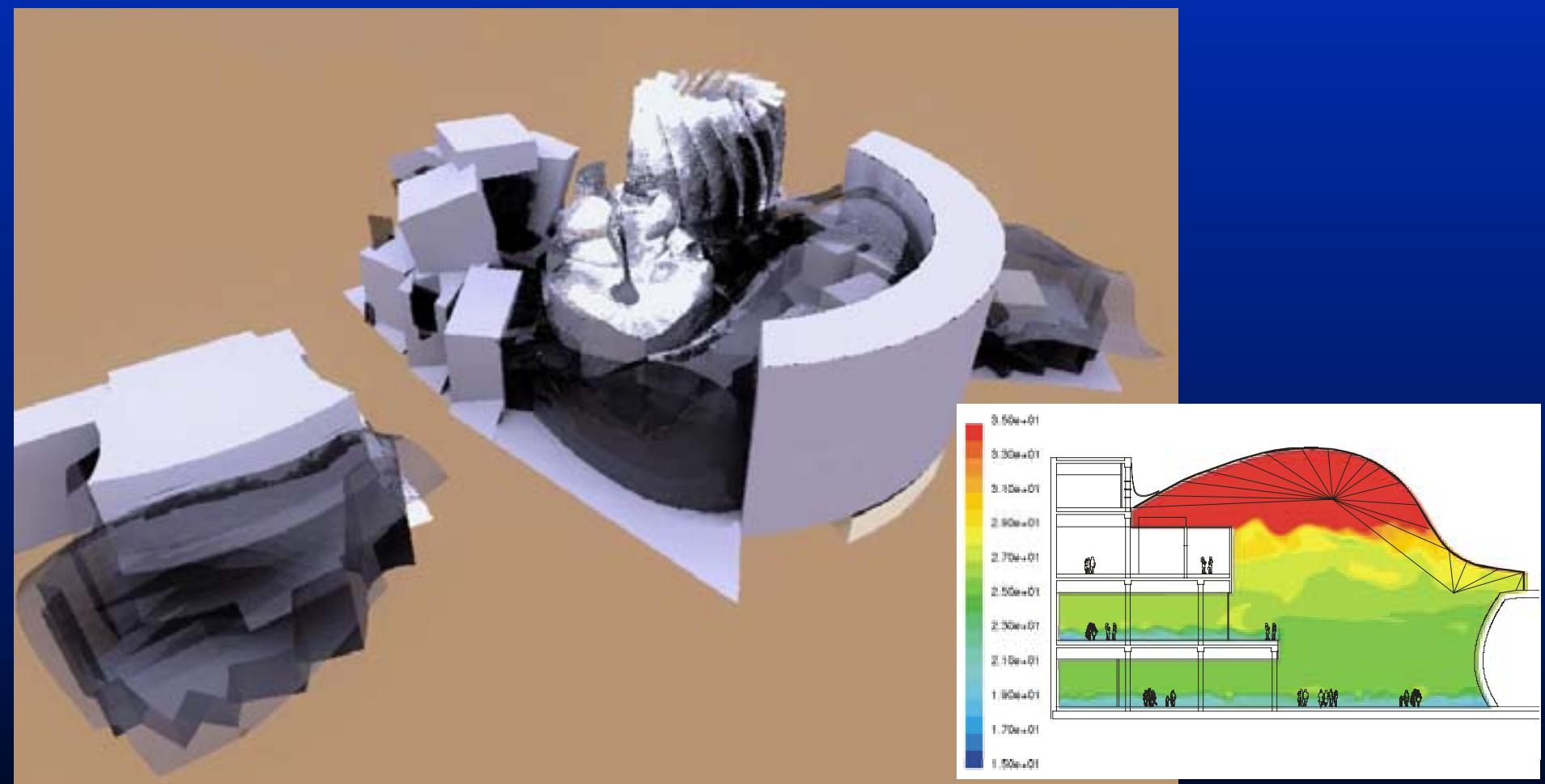


- Client:
DEMUTO, München
- Design team:
Architect: Behnisch & Partner
Structure: Pfefferkorn&P. /
Wetzel& von Seht
Energy concept: Transsolar
HVAC: Gierke,Becker / Grabe



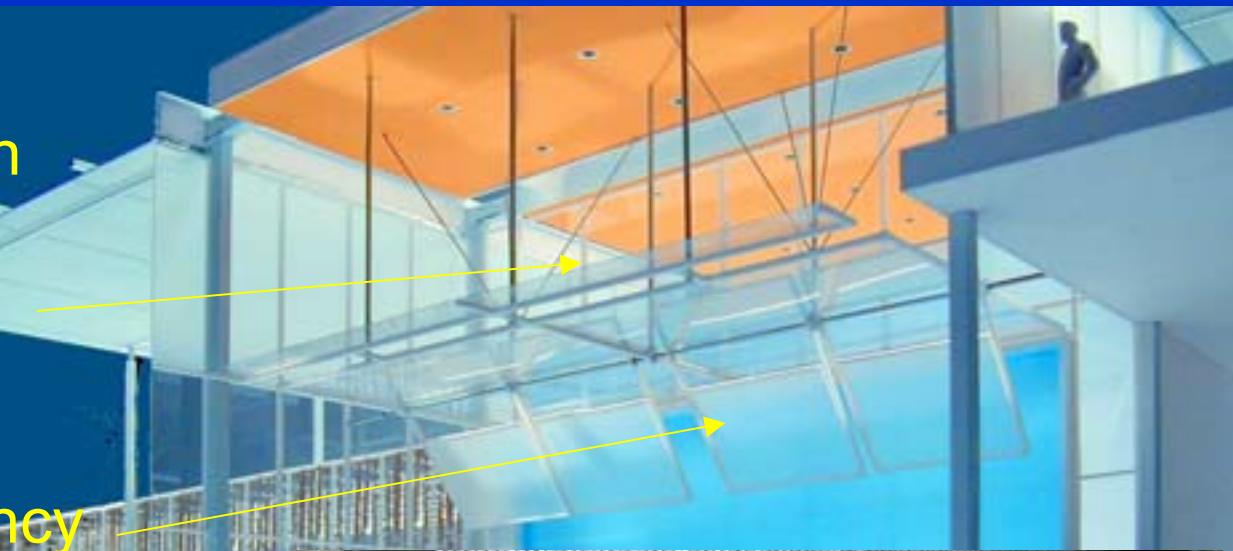
Norddeutsche Landesbank, Hannover

Architect: Frank O. Gehry
Structure: Schlaich, Bergermann
Energy concept: Transsolar
MEP: Cosentini, NY



Museum of Tolerance, Jerusalem

Exhaust air collection



Stratification layer

Flaps for air turbulence

Water wall



Client:

Tulane University

Architect:

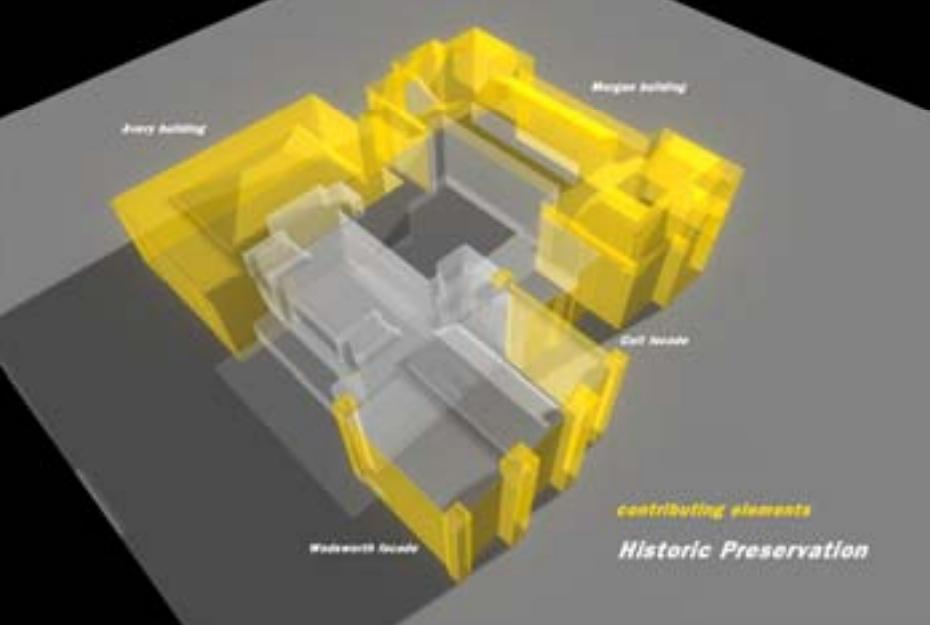
Vicent James,

Facade concept: James Carpenter Design

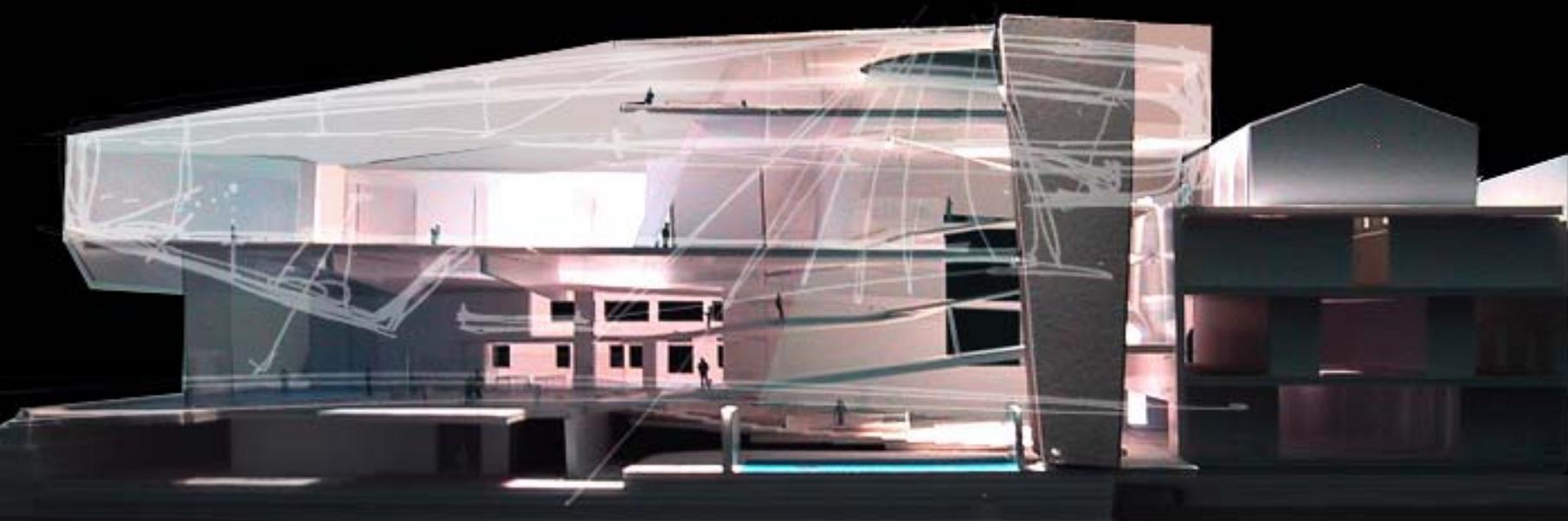
MEP: Moses Engine

Comfort concept: Transsolar Energietech

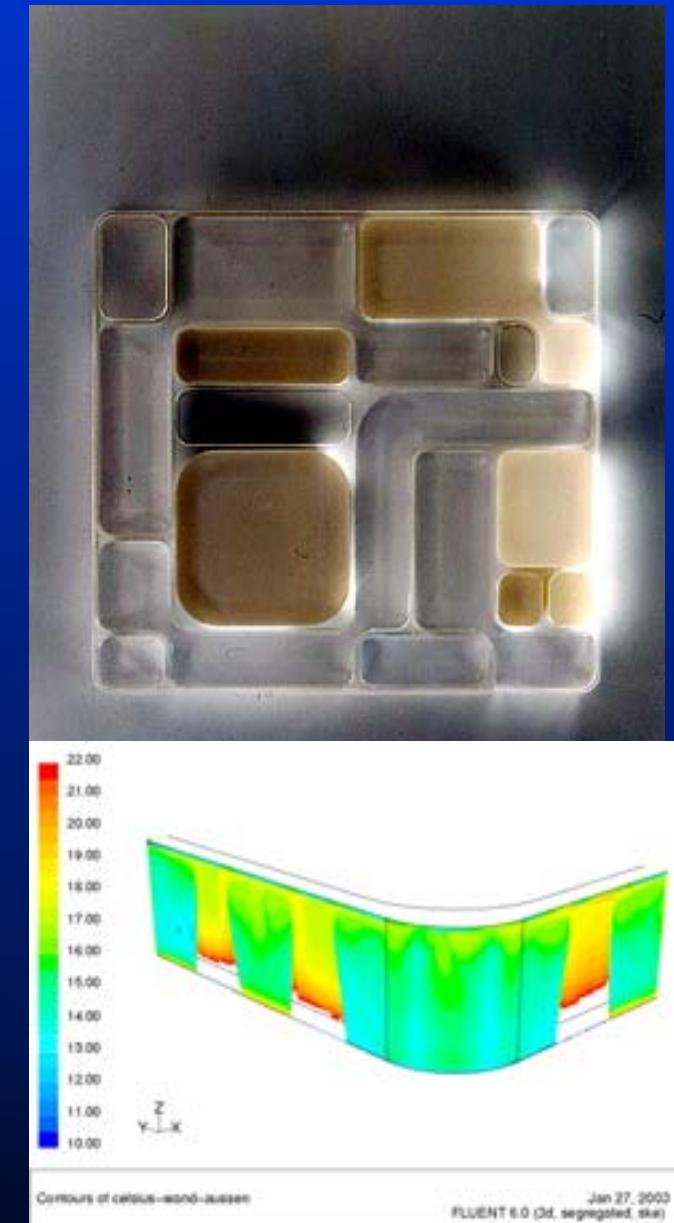
Refurbishment Faculty Club, Tulane University, New Orleans



Architect: Ben van Berkel
Structure: Ove Arup
Energy concept: Transsolar
MEP: Altieri Sebor



Wadsworth Atheneum, Hartford, CT



Architect: SANAA, Sejima Nishisawa, Tokio
Structure: Dewhorst McFarland, New York
Energy concept: Transsolar
MEP: Cosentini, New York



Center for Glass, Toledo Museum of Art, Toledo, Ohio

Detailed project example

Headquarter Deutsche Post

- Simulation is nowadays a standard tool in the integral design process, with big saving potentials
- Parallel building and system simulations are necessary for the integrated design concepts - no division between building and system possible
- Integral concepts with a sustainable background are economical approaches. It is proved by realized examples that sustainable buildings can be cheaper in construction and operational costs.
- Employees comfort is a big economical issue, increasing productivity and health.
- Slightly higher costs for the design ~ 10% of the fee pay back in investment savings of factor 10 and more.
- First strategies are related to the building not to systems or components and therefore an integral design approach.

Learning from Nature



Natural clouds

Indoor cloud for
„light & building“ fare,
Frankfurt 2002

